U. S. DEPARTMENT OF COMMERCE
BUREAU OF STANDARDS

THE OPTICAL ROTATION OF LIQUIDS ITS VARIATION WITH WAVE LENGTH TEMPERATURE, SOLVENT AND CONCENTRATION

By T. MARTIN LOWRY

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U. S. DEPARTMENT OF COMMERCE
R. P. LAMONT, Secretary
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PREFACE

The compilation of the available data on this topic, as presented in the following pages, was made in conjunction with work undertaken for the International Critical Tables and covers, with the exceptions noted below, the literature preceding January 1, 1923. No attempt has been made to include fragmentary data. Data for the sodium *D*-line at ordinary temperatures and in the common solvents will be found in International Critical Tables.[1] The common sugars have also been omitted from the present compilation, since they have been covered in the saccharimetry section of International Critical Tables.[2]

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[1] Int. Crit. Tables, **7**, pp. 355–489. McGraw-Hill Book Co., New York; 1931.
[2] Int. Crit. Tables, **2**, pp. 334–355. McGraw-Hill Book Co., New York; 1927.

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THE OPTICAL ROTATION OF LIQUIDS, ITS VARIATION WITH WAVE LENGTH, TEMPERATURE, SOLVENT, AND CONCENTRATION[1]

By T. Martin Lowry

I. ARRANGEMENT

Arrangement is by classes defined as follows:

CARBON COMPOUNDS[2]

I. None of the asymmetric carbon atoms forms part of a ring.
II. At least one asymmetric carbon atom forms part of a ring.
III. The compound contains no asymmetric carbon atom or contains at least one asymmetric or dissymmetric atom other than carbon.
IV. Substances of unknown, doubtful, or complex structure.

Classes I to IV are subdivided according to the number and nature of the asymmetric atoms as follows:

A_n The molecule contains *n* asymmetric atoms which are attached each to only one other carbon atom.
B_n The molecule contains *n* asymmetric atoms which are attached each to two other carbon atoms.
C_n The molecule contains *n* asymmetric atoms which are attached each to three other carbon atoms.
D_n The molecule contains *n* asymmetric atoms which are attached each to four other carbon atoms.

For substances which fall within two or more of the above subdivisions the higher (in the order D, C, B, A) division receives preference in deciding the arrangement. Within a subdivision the arrangement is in accordance with the value of *n* in the order 1, 2, 3, etc.

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[1] This section includes data and bibliography to January 1, 1924.

[2] Sugars and their derivatives are classed as open chain compounds. In general, derivatives are listed under the parent compound, even when they contain additional asymmetric atoms

II. SYMBOLS AND ABBREVIATIONS

t	Temperature in degrees centigrade (°C).
λ	Wave length of light expressed in Angstrom units; that is, in tenths of a millimicron ($\frac{1}{10}$ $\mu\mu$) unless otherwise indicated.
D	A wave length of 5893 A.
α_λ^t	Observed rotation at the given values for t.
$[\alpha]_\lambda^t$	Specific rotation at the given values for t.
$[M]_\lambda^t$	Molecular rotation at the given values for $t(=M\times[\alpha]_\lambda^t/100)$.
c	Concentration in grams per 100 cm^3 of solution.
p	Concentration in grams per 100 g of solution (= Wt. per cent). (Values in italics when column heading is "*c*" or "*p*.")
d	d_4^t = density at the given value for t referred to water at 4°C., unless otherwise indicated.
2 per cent NaOH (etc.)	2 per cent of solution of NaOH in water.
2 per cent NaOH MeOH	2 per cent of solution of NaOH in methyl alcohol.
M	Moles.
N NaOH	Normal aqueous solution of NaOH (=1 equivalent/liter).
s	Solvent.

SYMBOLS FOR SOLVENTS AND RADICALS

A ≡ The acid radical under which it is used.
Ac ≡ (CH_3CO) Acetyl.
Bu ≡ (C_4H_9) Butyl.
en ≡ ($C_2H_8N_2$) α, β-Ethylenediamine.
Et ≡ (C_2H_5) Ethyl.
Me ≡ (CH_3) Methyl.
Ph ≡ (C_6H_5) Phenyl.
pn ≡ ($C_3H_{10}N_2$) α, β-Propylenediamine.
Pr = (C_3H_7) Propyl.
Py ≡ (C_5H_5N) Pyridine.
tr ≡ ($C_3H_{10}N_2$) α, γ-Diaminopropane (trimethylenediamine).

III. Class I.—ORGANIC SUBSTANCES IN WHICH THE ASYMMETRIC CARBON ATOM DOES NOT FORM PART OF A RING

IB. THE MOLECULE CONTAINS 1 CARBON ATOM ATTACHED TO 4 DIFFERENT ATOMS OR GROUPS

CH_5ClINO_3S, ammonium chloriodomethanesulphonate (**176**)

		$[\alpha]_\lambda^{20}$		
s	*c*	5,461	5,781	5,893
H_2O	1.000	15.8	13.3	12.3
H_2O	1.674	16.0	13.4	12.4
H_2O	3.402	15.7	13.2	12.2
EtOH	1.671	19.5	16.8	15.7

NOTE.—Throughout this paper, black-face figures in parentheses refer to correspondingly numbered citations in the bibliography, p. 101.

IB$_1$ THE ASYMMETRIC CARBON ATOM IS ATTACHED TO 2 OTHER CARBON ATOMS

1. AMINES

Sec-butylamine (=Am) and derivatives (**171**) $\left[\alpha\right]_{\lambda}^{20}$

s=H_2O	Sulphonyl=Su	c \ λ	5,893	5,780	5,461
$C_4H_{11}N$	*l*-Am	4.70	−5.00	−5.22	−5.75
$C_4H_{12}ClN$	*l*-Am hydrochloride	3.40	.88	.96	1.25
$C_{11}H_{15}NO$	Benzoyl-*d*-Am	1.00	30.7	32.2	37.1
$C_{10}H_{15}NO_2S$	Benzene-Su-*d*-Am	3.01	2.40	2.49	2.49
$C_{11}H_{17}NO_2S$	*p*-Toluene-Su-*d*-Am	3.03	.81	.81	.81
$C_{14}H_{17}NO_2S$	Naphthalene-*α*-Su-*l*-Am	2.73	−5.40	−5.40	−5.58

$C_{15}H_{15}NO$, *benzoyl-l-α-phenylethylamine* (**174**; *cf.* **131**)

	$\left[\alpha\right]_{\lambda}^{20}$				$\left[M\right]_{\lambda}^{20}$
s	c \ λ	5,893	5,780	5,461	5,461
C_6H_6	3.004	−40.1	−41.9	−48.3	−137
C_6H_6	2.384	−43.7	−45.7	−52.6	−149
C_6H_6	.795	−52.5	−55.7	−64.2	−182

2. MONOHYDROXY ALCOHOLS, THEIR ETHERS AND ESTERS

Specific rotation $[\alpha]_\lambda^t$ *of carbinols*

(161; cf. 81)	Methyl carbinol [1]	$[\alpha]_D^{20}$	$[\alpha]_D^{50}$	$[\alpha]_D^{90}$	d-Methylethyl carbinol (164)					d-Methyl-n-hexyl carbinol (164)			
					$[\alpha]_\lambda$[2]					$[\alpha]_\lambda$[2]			
					s	c	5, 893	5, 461	4,358	c	5,893	5,461	4,358
$C_4H_{10}O$	-Ethyl	13.87	12.48	11.84	Py	5.26	18.42	21.61	37.00	5.04	10.31	11.70	20.22
$C_5H_{12}O$	-*n*-Propyl	13.70	12.89	12.56	CS_2	5.59	17.21	20.46	34.86	5.25	13.34	----	----
$C_6H_{14}O$	-*n*-Butyl	11.57	11.02	10.90	EtOAc	5.45	16.78	19.72	33.29	5.06	12.34	----	----
$C_7H_{16}O$	-*n*-Amyl	10.32	9.89	9.60	Me_2CO	4.98	16.39	18.79	31.79	5.04	10.51	----	----
$C_8H_{18}O$	-*n*-Hexyl	9.76	9.17	8.99	AcOH	5.04	16.28	18.66	31.77	5.27	10.81	----	----
$C_9H_{20}O$	-*n*-Heptyl	8.99	8.55	8.30	EtOH	5.38	14.60	16.89	28.28	5.46	9.79	----	----
$C_{10}H_{22}O$	-*n*-Octyl	8.68	8.14	7.80	C_6H_6	5.60	14.54	17.31	29.17	5.51	12.44	----	----
$C_{11}H_{24}O$	-*n*-Nonyl	8.13	7.66	7.28	$C_2H_4Br_2$	4.96	11.82	13.93	23.55	----	----	----	----
$C_{12}H_{26}O$	-*n*-Decyl	7.78	7.27	6.89	Phenetole	----	----	----	----	5.52	12.67	----	----
$C_{13}H_{28}O$	-*n*-Undecyl	7.22	6.67	6.39	C_6H_5Cl	----	----	----	----	5.34	12.26	----	----
					CCl_4	----	----	----	----	5.04	12.29	----	----
					$CHCl_3$	----	----	----	----	5.17	9.00	----	----

[1] These substances are stated to show simple dispersion. A 1-term Drude dispersion expression fits the data accurately (126).

[2] t=about 20°.

Ethyl carbinols (163; cf. 126)		$[\alpha]_D^{20}$	$[\alpha]_{5,461}^{20}$	$[M]_D^{20}$	$[M]_D^{60}$	$[M]_D^{100}$	$[M]_D^{140}$
$C_4H_{10}O$	Methyl	13.87	16.09	10.02	8.73	----------	----------
$C_5H_{12}O$	Ethyl	Optically inactive.					
$C_6H_{14}O$	Propyl	1.97	2.24	2.01	2.12	2.32	----------
$C_7H_{16}O$	Butyl	8.13	9.58	9.43	9.58	9.78	10.06
$C_8H_{18}O$	Amyl	8.22	9.64	10.69	10.95	11.14	11.24
$C_9H_{20}O$	Hexyl	7.38	8.63	10.63	11.10	11.15	11.04
$C_{10}H_{22}O$	Heptyl	6.68	7.76	10.55	10.66	10.64	10.49
$C_{11}H_{24}O$	Octyl	6.25	7.23	10.74	10.96	11.00	11.10
$C_{12}H_{26}O$	Nonyl	5.97	6.92	11.09	10.33	10.21	10.33
$C_{13}H_{28}O$	Decyl	6.23	7.21	12.44	12.28	12.13	12.11
$C_{14}H_{30}O$	Undecyl	5.87	6.80	12.56	12.28	12.19	12 16
$C_{15}H_{32}O$	Dodecyl	5.53	6.40	12.61	12.26	12.13	12.20
$C_{16}H_{34}O$	Tridecyl	5.11	5.92	12.38	12.34	12.11	11.76
$C_{18}H_{38}O$	Pentadecyl	4.77	5.49	12.87	12.80	12.72	12.63

Isopropyl carbinols (126, 162)		$[\alpha]_D^{20}$	$[M]_D^{20}$	$[M]_D^{1}$
$C_6H_{12}O$	Methyl	4.85	4.3	3.7
$C_6H_{14}O$	Ethyl	15.06	15.4	12.4
$C_7H_{16}O$	*n*-Propyl	21.25	24.7	21.9
$C_8H_{18}O$	*n*-Butyl	25.64	33.3	29.1
$C_9H_{20}O$	*n*-Amyl	22.84	32.9	28.7
$C_{10}H_{22}O$	*n*-Hexyl	21.46	33.9	29.2
$C_{12}H_{26}O$	*n*-Octyl	18.55	34.5	29.0
$C_{14}H_{30}O$	*n*-Decyl	16.15	34.5	29.0

[1] At boiling point.

Specific rotation $[\alpha]_{\lambda}^{t}$ *of carbinols* **(165; *cf.* 126)**

	5, 893	5, 461	4, 358	5, 893	5, 461	4, 358	5, 893	5, 461	4, 359	5, 893	5, 461	4, 358	5, 893	5, 461	4, 358	5, 893	5, 461	4, 358	5, 893	5, 461	4, 358
	$C_6H_{14}O$ *d*-Methyl-*tert*-butyl			$C_8H_{10}O$ *d*-Methylphenyl			$C_9H_{12}O$ *l*-Ethylphenyl			$C_9H_{12}O$ *d*-Methylbenzyl			$C_{10}H_{14}O$ *l*-Methyl-*β*-phenyl ethyl			$C_{12}H_{12}O$ *l*-Methyl-*α*-naphthyl			$C_{17}H_{22}O$ *d*-*n*-Hexyl-*α*-naphthyl		
10	------	------	------	------	------	------	------	------	------	------	------	------	−14. 23	−16. 84	−28. 11	−9. 79	−9. 61	−8. 01	−11. 26	−14. 89	−40. 25
20	7. 71	9. 09	15. 55	41. 77	49. 85	86. 64	−25. 86	−32. 91	−54. 95	26. 55	32. 19	59. 03	−14. 74	−17. 46	−29. 28	−14. 53	−16. 14	−19. 20	−1. 51	−2. 05	−12. 75
40	6. 84	8. 18	14. 08	41. 51	49. 46	85. 82	−30. 24	−36. 02	−60. 49	27. 58	33. 42	61. 22	−15. 17	−18. 03	−30. 45	−22. 95	−26. 51	−37. 97	12. 46	13. 85	16. 92
60	5. 94	7. 25	12. 52	41. 18	48. 97	84. 61	−32. 82	−38. 71	−65. 16	28. 32	34. 43	62. 70	−15. 61	−18. 47	−31. 44	−29. 80	−34. 23	−54. 76	23. 29	26. 89	40. 41
80	5. 27	6. 35	11. 07	40. 64	48. 32	83. 05	−34. 46	−40. 83	−68. 82	28. 56	34. 73	63. 36	−15. 90	−18. 79	−32. 03	−34. 46	−40. 19	−65. 27	31. 22	37. 47	58. 95
100	4. 58	5. 50	10. 00	40. 12	47. 56	81. 39	−35. 31	−42. 01	−70. 84	28. 47	34. 41	62. 94	−15. 97	−18. 89	−32. 32	−37. 59	−43. 98	−72. 71	37. 50	44. 37	72. 95
120	------	------	------	39. 31	46. 66	79. 60	−35. 51	−42. 11	−71. 03	28. 16	33. 83	61. 98	−15. 83	−18. 91	−32. 28	−38. 99	−45. 98	−77. 41	41. 03	48. 78	82. 58
140	------	------	------	38. 48	45. 77	77. 94	−35. 28	−41. 56	−70. 34	27. 46	33. 17	60. 57	------	------	------	−39. 25	−46. 66	−78. 41	42. 71	51. 34	87. 26
160	------	------	------	------	------	------	−34. 37	−40. 76	−69. 07	26. 59	32. 14	59. 07	------	------	------	−38. 88	−46. 70	−78. 56	43. 82	52. 86	89. 82
180	------	------	------	------	------	------	------	------	------	25. 64	31. 07	57. 41	------	------	------	−38. 51	−46. 05	−78. 14	44. 13	53. 67	90. 86
200	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	−37. 83	−45. 50	−76. 68	42. 62	51. 06	86. 26
s	The following are approximately 5 per cent solutions at room temperature (102, 165)																				
EtOH	4. 87	5. 86	10. 54	41. 94	49. 94	86. 26	−32. 48	−38. 59	−65. 06	16. 13	19. 36	36. 29	−19. 45	−23. 13	−38. 89	−74. 39	−89. 04	−159. 1	65. 37	80. 02	140. 8
C_6H_6	3. 31	3. 89	7. 78	48. 88	57. 93	99. 22	−40. 05	−47. 78	−79. 16	41. 82	50. 82	93. 58	−19. 41	−25. 45	−42. 79	−93. 87	−112. 6	−198. 9	74. 67	89. 97	156. 7
$CHCl_3$	. 59	. 79	1. 87	54. 13	65. 18	113. 2	−45. 45	−53. 67	−92. 23	39. 02	46. 72	85. 23	−17. 20	−20. 37	−34. 40	−65. 92	−78. 52	−138. 5	64. 76	78. 03	136. 2
CS_2	2. 18	2. 70	5. 32	58. 33	70. 01	123. 8	−45. 83	−54. 26	−93. 69	73. 57	89. 60	169. 1	−25. 68	−30. 78	−52. 65	−78. 25	−94. 34	−168. 5	60. 15	72. 52	124. 8
Py	2. 28	2. 74	5. 02	70. 66	84. 22	146. 9	−59. 50	−71. 39	−122. 7	47. 88	58. 02	106. 0	−17. 13	−20. 55	−34. 18	−70. 99	−85. 29	−148. 5	42. 36	50. 58	87. 24
													$s=COMe_2$		------	−74. 01	−89. 02	−157. 2	71. 48	85. 54	155. 5
													$s=C_2H_4Br_2$		−34. 40	−56. 11	−67. 04	−116. 8	54. 46	64. 00	115. 0

Specific rotation $[\alpha]_\lambda^t$ *of ethers of d-benzylmethyl carbinol* **(159)**

t	20	40	60	80	100	120	140	20	40	60	80	100	120	140
λ	$C_{10}H_{14}O$ methyl							$C_{11}H_{16}O$ ethyl						
6,438	4.58	4.20	3.73	3.26	2.68	2.19	----------	17.78	17.16	16.39	15.62	14.83	14.19	13.77
5,461	6.35	5.53	4.73	4.07	3.40	2.71	----------	25.75	24.68	23.40	22.47	21.46	20.43	19.54
5,086	7.63	6.71	5.75	4.77	3.99	3.23	----------	30.27	29.16	27.99	26.79	25.69	24.67	23.63
4,800	8.75	7.75	6.68	5.61	4.57	3.60	----------	35.14	33.91	32.54	31.18	29.74	28.40	27.06
4,678	9.28	8.23	7.12	6.06	4.94	3.98	----------	37.33	36.15	34.82	33.46	32.08	30.70	29.25
4,358	10.80	9.27	7.75	6.47	5.38	4.35	----------	44.34	42.69	40.94	39.13	37.36	35.54	33.67
	$C_{12}H_{18}O$ n-propyl							$C_{13}H_{20}O$ n-butyl						
6,438	17.78	17.31	16.79	16.15	15.38	14.83	----------	19.42	19.03	18.50	17.80	17.24	16.67	16.43
5,461	25.93	25.09	23.90	22.78	21.83	21.15	----------	27.90	26.99	26.01	24.95	23.95	23.11	22.43
5,086	30.66	29.75	28.39	27.08	26.10	25.32	----------	33.09	32.03	30.82	29.70	28.70	27.84	26.99
4,800	34.99	33.98	32.62	30.97	29.79	29.10	----------	37.93	36.75	35.41	34.13	32.91	31.85	30.94
4,678	37.26	35.97	34.42	32.80	31.49	30.86	----------	39.90	38.67	37.38	36.04	34.77	33.62	32.58
4,358	44.63	43.00	41.02	39.21	37.58	36.59	----------	48.22	46.38	44.49	42.71	41.31	40.05	39.05
	$C_{14}H_{22}O$ n-amyl							$C_{15}H_{24}O$ n-hexyl						
5,893	22.75	22.08	21.43	20.66	19.71	18.66	17.73	22.83	22.18	21.53	20.83	20.27	19.91	19.79
5,461	26.85	25.99	25.23	24.46	23.48	22.31	21.17	27.03	26.01	25.11	24.18	23.52	23.00	22.81
4,358	46.48	45.03	43.51	41.88	39.94	38.04	36.20	46.40	44.77	43.21	41.79	40.68	39.82	39.22
	$C_{16}H_{26}O$ n-heptyl							$C_{17}H_{28}O$ n-octyl						
6,438	18.10	17.55	16.85	16.43	15.93	15.52	15.16	17.29	16.73	16.23	15.63	15.19	14.80	14.44
5,461	25.84	24.99	24.03	23.20	22.49	21.86	21.28	25.14	24.29	23.42	22.66	21.91	21.16	20.70
5,086	30.43	29.43	28.34	27.45	26.67	25.84	24.98	29.43	28.61	27.59	26.62	25.77	24.98	24.15
4,800	34.92	33.75	32.59	31.61	30.60	29.57	28.61	33.67	32.91	31.94	30.92	29.84	28.89	27.99
4,678	36.90	35.82	34.60	33.50	32.48	31.49	30.35	35.76	34.85	33.71	32.56	31.46	30.54	29.63
4,358	44.26	42.67	41.08	39.53	38.32	37.35	36.38	42.56	41.49	40.24	38.95	37.52	36.21	35.14

$C_{18}H_{30}O$ n-nonyl	
t \ λ	5,893
20	20.78
40	20.20
60	19.48
80	18.91
100	18.59
120	18.26
140	18.01
t \ λ	5,461
20	24.85
40	24.01
60	23.29
80	22.50
100	21.82
120	21.35
140	20.76
t \ λ	4,358
20	42.08
40	40.80
60	39.56
80	38.40
100	37.26
120	36.16
140	35.26

Specific rotation $[\alpha]_{\lambda}^{t}$ *of ethers of d-benzylmethyl carbinol* (**159**)

$t=17°$	$s=EtOH$				CS_2			
Ether	λ c	5, 893	5, 461	4, 358	λ c	5, 893	5, 461	4, 358
Methyl	5. 00	2. 8	4. 9	7. 3	5. 00	36. 2	39. 5	81. 3
Ethyl	4. 95	19. 7	24. 4	41. 1	5. 01	44. 4	51. 4	94. 3
Propyl	5. 01	21. 1	24. 0	41. 3	5. 00	42. 8	52. 1	93. 2
Butyl	5. 00	25. 3	30. 6	49. 4	4. 98	42. 7	53. 0	95. 2
Amyl	4. 91	25. 6	31. 1	51. 1	5. 01	41. 5	48. 1	89. 1
Hexyl	5. 04	25. 5	30. 7	50. 3	4. 99	41. 2	49. 9	90. 3
Heptyl	5. 07	24. 8	29. 8	49. 3	4. 87	38. 1	47. 2	82. 1
Octyl	4. 95	24. 2	29. 8	49. 0	5. 05	37. 9	45. 6	81. 9
Nonyl	5. 04	24. 4	29. 7	48. 6	4. 96	37. 5	44. 6	80. 6

Specific rotation of d-β-octyl ethers

d-β-Octyl ether		$[\alpha]_{\lambda}^{20}$						(100)	$[\alpha]_{\lambda}^{120}$					
		6, 438	5, 461	5, 086	4, 800	4, 678	4, 358		6, 438	5, 461	5, 086	4, 800	4, 678	4, 358
$C_9H_{20}O$	Methyl	6. 42	8. 63	10. 20	11. 66	12. 23	13. 79	-----	3. 02	4. 52	5. 80	6. 70	7. 18	8. 35
$C_{10}H_{22}O$	Ethyl	14. 68	20. 33	24. 13	26. 95	28. 46	32. 86	-----	10. 79	14. 73	17. 15	19. 54	20. 32	23. 04
$C_{11}H_{24}O$	*n*-Propyl	-----	20. 51	-----	-----	-----	32. 92	-----	-----	15. 78	-----	-----	-----	25. 65
$C_{12}H_{26}O$	*n*-Butyl	16. 63	22. 46	26. 13	29. 64	31. 01	36. 13	-----	12. 34	17. 61	19. 61	21. 88	23. 19	27. 32
$C_{13}H_{28}O$	*n*-Amyl	13. 03	18. 19	22. 09	23. 83	25. 42	29. 06	-----	10. 34	14. 19	16. 56	18. 92	19. 86	22. 87
$C_{14}H_{30}O$	*n*-Hexyl	11. 68	16. 29	18. 68	21. 05	22. 45	25. 95	-----	8. 65	12. 36	14. 39	15. 68	16. 97	19. 54
$C_{15}H_{32}O$	*n*-Heptyl	13. 18	18. 41	21. 58	24. 11	25. 72	29. 75	-----	10. 42	14. 62	16. 48	19. 05	19. 73	22. 85
$C_{16}H_{34}O$	*n*-Octyl	10. 80	15. 33	17. 59	19. 96	20. 84	24. 77	-----	7. 95	11. 29	12. 88	14. 47	14. 98	18. 11
$C_{17}H_{36}O$	*n*-Nonyl	10. 98	15. 45	18. 41	20. 26	21. 35	24. 60	-----	8. 98	12. 43	14. 52	15. 96	16. 70	19. 82
	c	$s=CS_2\ [\alpha]_{\lambda}^{t}$[1]						*c*	$s=EtOH\ [\alpha]_{\lambda}^{t}$[1]					
$C_9H_{20}O$	4. 97	12. 31	20. 44	24. 31	28. 10	29. 10	35. 95	19. 60	6. 37	7. 52	8. 92	9. 30	10. 07	12. 24
$C_{10}H_{22}O$	4. 73	24. 27	32. 68	41. 50	45. 85	47. 93	58. 16	24. 75	13. 94	17. 68	22. 22	25. 35	26. 57	30. 00
$C_{11}H_{24}O$	5.47	-----	31. 42	-----	-----	-----	56. 26	25. 50	-----	17. 24	-----	-----	-----	28. 99
$C_{12}H_{26}O$	4.56	24. 58	33. 79	39. 60	45. 86	48. 71	57. 81	22. 65	15. 67	19. 86	24. 06	26. 93	28. 03	33. 36
$C_{13}H_{28}O$	3.53	19. 00	25. 42	30. 62	34. 16	36. 61	43. 81	24. 05	12. 37	15. 50	18. 82	21. 12	21. 84	25. 28
$C_{14}H_{30}O$	3.17	17. 97	23. 96	27. 51	33. 16	34. 99	40. 83	17. 60	12. 91	13. 85	18. 59	20. 01	21. 85	24. 69
$C_{15}H_{32}O$	4.26	19. 15	26. 20	32. 90	37. 71	39. 50	45. 23	24. 20	13. 22	17. 66	20. 96	23. 13	24. 99	27. 88
$C_{16}H_{34}O$	3.41	16. 14	20. 00	25. 98	29. 20	30. 09	35. 52	14. 65	10. 26	14. 02	15. 73	17. 78	18. 46	21. 37
$C_{17}H_{36}O$	3.30	-----	21. 50	-----	-----	-----	27. 40	21. 05	-----	14. 97	-----	-----	-----	26. 35

[1] t=room temperature.

Specific rotation $\left[\alpha\right]_{\lambda}^{t}$ *of alkyl esters at various temperatures* **(164, 166)**

	t	5, 461	5, 893	5, 461	5, 893	5, 461	5, 893	5, 461	5, 893	5, 461	5, 983	5, 461	5, 893	5, 461	5, 893
		Acetate $C_6H_{12}O_2$		Propionate $C_7H_{14}O_2$		*n*-Butyrate $C_8H_{16}O_2$		*n*-Valerate $C_9H_{18}O_2$		Caproate $C_{10}H_{20}O_2$		Enanthate $C_{11}H_{22}O_2$		Caprylate $C_{12}H_{24}O_2$	
d-β-Butyl esters	20	30.17	25.43	28.19	23.85	25.96	21.97	24.53	20.72	22.07	18.66	20.48	17.37	19.04	16.14
	40	28.15	23.69	26.47	22.37	24.19	20.44	23.10	19.50	20.53	17.18	19.22	16.24	17.97	15.13
	60	26.29	22.14	24.74	20.91	22.61	19.09	21.65	18.27	19.16	16.15	18.00	15.19	16.82	14.22
	80	24.79	20.85	23.33	19.71	21.50	18.18	20.22	17.10	18.02	15.17	16.99	14.32	15.83	13.33
	100	23.40	19.66	------	------	20.35	17.18	18.94	16.00	17.04	14.44	16.03	13.54	14.84	12.52
	120	------	------	------	------	19.36	16.33	17.90	15.13	16.04	13.53	15.03	12.71	13.99	11.84
	140	------	------	------	------	------	------	17.02	14.40	15.26	12.90	14.30	12.04	13.30	12.24
	160	------	------	------	------	------	------	------	------	------	------	13.76	11.60	12.75	10.77
		Pelargonate $C_{13}H_{26}O_2$		Undecylate $C_{15}H_{30}O_2$		Laurate $C_{16}H_{32}O_2$		Myristate $C_{18}H_{36}O_2$		Palmitate $C_{20}H_{40}O_2$		Stearate $C_{22}H_{44}O_2$			
	20	17.80	15.03	15.81	13.42	15.03	12.69	13.42	11.34	12.12	10.25	11.14	9.39	------	------
	40	16.73	14.14	14.83	12.48	14.11	11.91	12.70	10.69	11.44	9.65	10.47	8.83	------	------
	60	15.75	13.31	13.97	11.73	13.22	11.13	11.95	10.07	10.81	9.12	9.86	8.32	------	------
	80	14.82	12.51	13.13	11.09	12.39	10.43	11.26	9.50	10.23	8.61	9.32	7.89	------	------
	100	13.96	11.76	12.40	10.47	11.69	9.83	10.55	8.91	9.62	8.10	8.89	7.48	------	------
	120	13.11	11.10	11.81	9.98	11.15	9.41	9.95	8.41	9.11	7.68	8.45	7.12	------	------
	140	12.51	10.59	11.26	9.45	10.57	8.92	9.44	7.95	8.67	7.29	8.01	6.75	------	------
	160	12.25	10.33	10.69	8.99	10.07	8.50	9.03	7.65	------	------	7.66	6.48	------	------
		Acetate $C_7H_{14}O_2$		Propionate $C_8H_{16}O_2$		*n*-Butyrate $C_9H_{18}O_2$		*n*-Valerate $C_{10}H_{20}O_2$		Caproate $C_{11}H_{22}O_2$					
d-β-Amyl esters	20	20.27	17.16	19.29	16.43	18.42	15.77	18.77	16.01	22.48	18.74	------	------	------	------
	40	18.44	15.67	17.85	15.24	16.89	14.46	17.13	14.70	20.27	16.87	------	------	------	------
	60	17.04	14.50	16.44	14.03	15.46	13.23	15.98	13.63	18.19	15.04	------	------	------	------
	80	15.58	13.26	15.26	13.00	14.09	12.08	14.84	12.71	16.19	13.48	------	------	------	------
	100	14.54	12.36	14.25	12.15	13.29	11.34	13.98	11.95	------	------	------	------	------	------
	120	13.87	11.85	13.47	11.49	12.69	10.86	13.27	11.32	------	------	------	------	------	------
	140	------	------	------	------	------	------	12.62	10.80	------	------	------	------	------	------
		Acetate $C_8H_{16}O_2$		Propionate $C_9H_{18}O_2$		*n*-Butyrate $C_{10}H_{20}O_2$		*n*-Valerate $C_{11}H_{22}O_2$		Caproate $C_{12}H_{24}O_2$		Enanthate $C_{13}H_{26}O_2$			
d-β-Hexyl esters	20	11.80	10.13	11.41	9.76	12.66	10.83	13.05	11.16	12.66	10.84	12.12	10.36	------	------
	40	10.30	8.85	10.17	8.73	11.47	9.76	11.97	10.26	11.69	9.96	11.11	9.50	------	------
	60	8.92	7.68	9.06	7.80	10.32	8.81	10.92	9.39	10.69	9.16	10.18	8.73	------	------
	80	7.67	6.58	8.06	6.91	9.32	7.94	9.87	8.48	9.85	8.41	9.28	7.96	------	------
	100	6.53	5.59	7.19	6.16	8.33	7.13	9.08	7.74	9.03	7.74	8.56	7.31	------	------
	120	5.66	4.88	------	------	7.65	6.53	8.27	7.08	8.32	7.14	7.94	6.78	------	------
	140	------	------	------	------	7.02	5.98	7.61	6.52	7.66	6.60	7.43	6.31	------	------
		Pelargonate $C_{15}H_{30}O_2$		Undecylate $C_{17}H_{34}O_2$		Laurate $C_{18}H_{36}O_2$		Myristate $C_{20}H_{40}O_2$		Palmitate $C_{22}H_{44}O_2$		Stearate $C_{24}H_{48}O_2$			
	20	10.96	9.38	9.75	8.35	9.34	7.99	8.66	7.40	8.10	6.87	7.21	6.16	------	------
	40	10.09	8.61	8.97	7.67	8.53	7.27	7.84	6.70	7.44	6.31	6.44	5.52	------	------
	60	9.26	7.87	8.17	7.00	7.75	6.64	7.18	6.14	6.84	5.87	5.88	5.02	------	------
	80	8.46	7.19	7.56	6.48	7.11	6.09	6.60	5.62	6.26	5.37	5.43	4.65	------	------
	100	7.77	6.63	7.02	6.02	6.52	5.60	6.09	5.21	5.81	4.97	5.03	4.31	------	------
	120	7.24	6.21	6.49	5.55	6.01	5.16	5.66	4.84	5.51	4.70	4.68	4.02	------	------
	140	6.73	5.84	5.99	5.15	5.64	4.82	5.29	4.53	5.31	4.55	4.40	3.78	------	------
	160	------	------	------	------	------	------	5.03	4.30	------	------	4.21	3.58	------	------

Specific rotation $[\alpha]^t_\lambda$ *of alkyl esters at various temperatures* **(164, 166)**—Continued

	t	5,461	5,893	5,461	5,893	5,461	5,893	5,461	5,893	5,461	5,893	5,461	5,893	5,461	5,893
		Acetate $C_9H_{18}O_2$		Propionate $C_{10}H_{20}O_2$		*n*-Butyrate $C_{11}H_{22}O_2$		*n*-Valerate $C_{12}H_{24}O_2$		Caproate $C_{13}H_{26}O_2$		Enanthate $C_{14}H_{28}O_2$		Caprylate $C_{15}H_{30}O_2$	
d-β-Heptyl esters	20	9.55	8.23	9.77	8.37	11.86	10.16	12.02	10.26	11.63	9.97	11.16	9.53	10.62	9.07
	40	8.07	6.91	8.67	7.40	10.80	9.24	11.07	9.48	10.38	8.90	10.31	8.80	9.77	8.32
	60	6.88	5.89	7.64	6.53	9.72	8.34	10.20	8.70	9.48	8.12	9.49	8.09	8.97	7.64
	80	5.89	5.03	6.67	5.72	8.78	7.52	9.32	7.99	8.76	7.50	8.78	7.49	8.21	7.01
	100	4.85	4.16	5.70	4.88	7.91	6.78	8.57	7.34	8.12	6.95	8.07	6.88	7.56	6.48
	120	3.92	3.35	4.85	4.14	7.13	6.12	7.83	6.70	7.48	6.39	7.43	6.35	6.97	5.96
	140	------	------	------	------	6.47	5.44	7.16	6.13	7.07	6.03	6.89	5.87	6.51	5.56
	160	------	------	------	------	6.03	5.16	6.62	5.66	------	------	6.47	5.51	6.15	5.24
		Pelargonate $C_{16}H_{32}O_2$		Undecylate $C_{18}H_{36}O_2$		Laurate $C_{19}H_{38}O_2$		Myristate $C_{21}H_{42}O_2$		Palmitate $C_{23}H_{46}O_2$		Stearate $C_{25}H_{50}O_2$			
	20	10.15	8.70	9.28	7.96	8.85	7.58	8.10	6.91	7.69	6.53	7.10	6.06	------	------
	40	9.40	8.04	8.65	7.40	8.28	7.08	7.50	6.40	6.97	5.98	6.38	5.42	------	------
	60	8.62	7.36	7.98	6.84	7.62	6.49	6.91	5.89	6.32	5.40	5.79	4.95	------	------
	80	7.92	6.77	7.41	6.36	6.97	5.95	6.36	5.42	5.80	4.96	5.31	4.55	------	------
	100	7.25	6.21	6.88	5.86	6.38	5.45	5.91	5.05	5.43	4.63	5.03	4.31	------	------
	120	6.72	5.76	6.41	5.46	5.85	5.00	5.54	4.74	5.08	4.34	4.65	3.98	------	------
	140	6.33	5.42	6.00	5.11	5.46	4.67	5.14	4.38	4.74	4.05	4.35	3.73	------	------
	160	6.10	5.20	5.54	4.73	5.16	4.41	4.85	4.15	4.40	3.77	------	------	------	------
		Acetate $C_{10}H_{20}O_2$		Propionate $C_{11}H_{22}O_2$		*n*-Butyrate $C_{12}H_{24}O_2$		*n*-Valerate $C_{13}H_{26}O_2$		Caproate $C_{14}H_{28}O_2$		Enanthate $C_{15}H_{30}O_2$		Caprylate $C_{16}H_{32}O_2$	
d-β-Octyl esters	20	8.01	6.84	8.16	6.98	10.46	8.95	10.65	9.16	10.54	8.96	9.97	8.59	9.61	8.25
	40	6.85	5.84	6.98	5.98	9.48	8.12	9.16	7.83	9.52	8.16	9.31	7.95	8.69	7.40
	60	5.67	4.85	6.00	5.14	8.50	7.29	8.22	7.03	8.66	7.42	8.52	7.30	7.87	6.74
	80	4.59	3.93	5.14	4.40	7.63	6.54	7.46	6.36	7.92	6.79	7.73	6.63	7.20	6.18
	100	3.67	3.15	4.35	3.72	6.87	5.90	6.85	5.84	7.27	6.24	6.99	6.01	6.66	5.71
	120	2.68	2.37	3.64	3.11	6.12	5.24	6.22	5.31	6.73	5.73	6.40	5.45	6.15	5.28
	140	1.82	1.70	3.04	2.60	5.50	4.70	5.68	4.86	6.24	5.34	5.98	5.11	5.69	4.87
	160	1.20	1.15	------	------	4.97	4.26	5.21	4.44	------	------	5.66	4.88	------	------
	180	.60	.85	------	------	------	------	------	------	------	------	------	------	------	------
		Pelargonate $C_{17}H_{34}O_2$		Undecylate $C_{19}H_{38}O_2$		Laurate $C_{20}H_{40}O_2$		Myristate $C_{22}H_{44}O_2$		Palmitate $C_{24}H_{48}O_2$		Stearate $C_{26}H_{52}O_2$			
	20	9.34	7.96	8.57	7.35	8.21	7.00	7.72	6.59	7.18	6.14	6.68	5.71	------	------
	40	8.50	7.29	7.90	6.77	7.53	6.47	7.05	6.02	6.58	5.64	6.19	5.28	------	------
	60	7.83	6.71	7.24	6.18	6.91	5.94	6.43	5.48	6.10	5.21	5.69	4.86	------	------
	80	7.22	6.19	6.59	5.61	6.40	5.45	5.84	4.99	5.62	4.79	5.19	4.45	------	------
	100	6.73	5.72	6.03	5.09	5.88	5.02	5.35	4.59	5.18	4.41	4.83	4.12	------	------
	120	6.30	5.36	5.54	4.73	5.44	4.66	5.03	4.31	4.80	4.10	4.47	3.83	------	------
	140	5.92	5.06	5.23	4.47	5.05	4.29	4.71	4.04	4.42	3.78	4.12	3.53	------	------
	160	5.67	4.83	------	------	4.73	4.03	------	------	------	------	3.78	3.23	------	------

Specific rotation $\left[\alpha\right]_{\lambda}^{t}$ *of alkyl esters at various temperatures* (**164, 166**)—Continued

t	5, 461	5, 893	5, 461	5, 893	5, 461	5, 893	5, 461	5, 893	5, 461	5, 893	5, 461	5, 893		
d-β-Undecyl esters	Acetate $C_{13}H_{26}O_2$		Propionate $C_{14}H_{28}O_2$		*n*-Butyrate $C_{15}H_{30}O_2$		*n*-Valerate $C_{16}H_{32}O_2$		Caproate $C_{17}H_{34}O_2$		Enanthate $C_{18}H_{36}O_2$			
20	6. 17	5. 27	6. 04	5. 15	8. 57	7. 31	8. 72	7. 46	8. 63	7. 37	8. 36	7. 17	------	------
40	4. 94	4. 24	5. 12	4. 40	7. 52	6. 40	7. 79	6. 67	7. 85	6. 69	7. 71	6. 60	------	------
60	3. 90	3. 35	4. 39	3. 75	6. 58	5. 62	6. 95	5. 96	7. 10	6. 07	7. 13	6. 10	------	------
80	3. 08	2. 62	3. 71	3. 17	5. 83	4. 99	6. 19	5. 30	7. 46	5. 52	6. 51	5. 57	------	------
100	2. 36	2. 02	3. 06	2. 60	5. 28	4. 49	5. 57	4. 76	5. 94	5. 09	5. 93	5. 07	------	------
120	2. 07	1. 87	2. 53	2. 15	4. 77	4. 07	5. 03	4. 30	5. 50	4. 69	5. 36	4. 57	------	------
140	1. 19	1. 17	2. 08	1. 75	4. 32	3. 70	4. 63	3. 97	5. 11	4. 36	4. 91	4. 22	------	------
160	. 61	. 47	------	------	------	------	4. 34	3. 69	4. 79	4. 08	4. 68	4. 01	------	------
180	−. 11	+. 11	------	------	------	------	------	------	------	------	------	------	------	------
	Pelargonate $C_{20}H_{40}O_2$		Undecylate $C_{22}H_{44}O_2$		Laurate $C_{23}H_{46}O_2$		Myristate $C_{25}H_{50}O_2$							
20	7. 96	6. 81	7. 38	6. 30	7. 21	6. 19	6. 68	5. 72	------	------	------	------	------	------
40	7. 27	6. 21	6. 75	5. 76	6. 67	5. 70	6. 09	5. 21	------	------	------	------	------	------
60	6. 68	5. 71	6. 15	5. 25	6. 16	5. 27	5. 48	4. 71	------	------	------	------	------	------
80	6. 16	5. 29	5. 65	4. 85	5. 57	4. 77	4. 97	4. 25	------	------	------	------	------	------
100	5. 69	4. 87	5. 20	4. 43	5. 04	4. 32	4. 63	3. 98	------	------	------	------	------	------
120	5. 20	4. 44	4. 80	4. 11	4. 75	4. 09	4. 33	3. 71	------	------	------	------	------	------
140	4. 79	4. 10	4. 50	3. 85	4. 52	3. 87	4. 11	3. 50	------	------	------	------	------	------
160	4. 46	3. 82	4. 27	3. 66	4. 29	3. 67	3. 99	3. 42	------	------	------	------	------	------
	Formates				Acetates									
	d-β-Butyl $C_5H_{10}O_2$		*d-β*-Octyl $C_9H_{18}O_2$		*d-β*-Nonyl $C_{11}H_{22}O_2$		*d-β*-Decyl $C_{12}H_{24}O_2$		*d-β*-Tridecyl $C_{15}H_{30}O_2$					
20	22. 48	18. 74	−5. 04	−4. 16	7. 24	6. 21	6. 61	5. 64	5. 39	4. 63	------	------	------	------
40	20. 27	16. 87	−6. 43	−5. 35	5. 76	4. 92	5. 44	4. 67	4. 45	3. 83	------	------	------	------
60	18. 19	15. 04	−7. 84	−6. 45	4. 73	4. 04	4. 36	3. 73	3. 54	3. 03	------	------	------	------
80	16. 19	13. 48	−9. 15	−7. 45	3. 80	3. 26	3. 36	2. 88	2. 75	2. 36	------	------	------	------
100	------	------	−10. 38	−8. 36	2. 90	2. 49	2. 56	2. 19	2. 11	1. 79	------	------	------	------
120	------	------	−11. 25	−9. 04	2. 06	1. 74	1. 85	1. 60	1. 55	1. 35	------	------	------	------
140	------	------	−11. 85	−9. 47	1. 28	1. 09	1. 12	1. 11	1. 05	. 89	------	------	------	------
160	------	------	------	------	. 60	. 50	. 57	−. 54	. 51	. 40	------	------	------	------
180	------	------	------	------	------	------	------	------	±. 00	±. 00	------	------	------	------
	Laurates													
	d-β-Amyl $C_{17}H_{34}O_2$		*d-β*-Nonyl $C_{21}H_{42}O_2$		*d-β*-Decyl $C_{22}H_{44}O_2$		*d-β*-Dodecyl $C_{24}H_{48}O_2$		*d-β*-Tridecyl $C_{25}H_{50}O_2$					
20	12. 24	10. 44	7. 87	6. 71	7. 51	6. 41	6. 99	5. 99	6. 83	5. 87	------	------	------	------
40	11. 42	9. 17	7. 15	6. 12	7. 05	6. 02	6. 42	5. 49	6. 21	5. 33	------	------	------	------
60	10. 75	9. 16	6. 53	5. 60	6. 40	5. 47	5. 91	5. 07	5. 64	4. 86	------	------	------	------
80	10. 17	8. 69	5. 98	5. 14	5. 72	4. 88	5. 45	4. 67	5. 20	4. 47	------	------	------	------
100	9. 65	8. 21	5. 48	4. 67	5. 18	4. 42	5. 04	4. 31	4. 81	4. 13	------	------	------	------
120	9. 17	7. 80	5. 05	4. 31	4. 81	4. 11	4. 69	4. 01	4. 46	3. 82	------	------	------	------
140	8. 74	7. 43	4. 69	4. 01	4. 60	3. 92	4. 37	3. 72	4. 22	3. 62	------	------	------	------
160	------	------	4. 35	3. 72	4. 45	3. 78	4. 10	3. 50	4. 10	3. 50	------	------	------	------

Specific rotation $[\alpha]^t_\lambda$ *of alkyl esters in various solvents (5 per cent concentration)* **(164)**

t=Room temp. λ=	5,893	5,461	4,358	5,893	5,461	4,358	5,893	5,461	4,358	5,893	5,461	4,358	5,893	5,461	4,358
s=	Ethyl alcohol			Pyridine			Benzene			Carbon disulphide			Ethyl alcohol		
Ester	β-Butyl esters												β-Hexyl esters		
Acetate	25.87	30.45	50.06	18.56	21.78	35.13	21.92	26.10	43.73	15.62	18.31	27.53	6.94	7.66	11.64
Propionate	24.69	29.10	47.48	17.22	20.22	32.80							7.47	7.99	12.56
n-Butyrate	22.80	26.40	44.69	16.29	18.49	29.49							9.11	10.28	16.46
n-Valerate	21.40	25.04	40.90										10.34	11.42	18.40
Caproate	19.28	22.78	37.36				14.42	16.29	27.52	8.92	10.00	15.58	10.05	10.86	18.23
Enanthate	18.03	21.15	34.99	12.80	14.92	23.18	13.49	15.91	26.51				9.82	11.38	17.74
Caprylate	16.95	19.83	32.95	12.09	13.44	21.77									
Pelargonate	15.82	18.33	30.19	11.42	13.04	21.22	11.93	13.93	23.12	8.40	10.01	15.01	8.99	10.09	16.24
Undecylate	14.38	16.51	27.79	10.03	12.90	19.03				7.03	8.81	12.20			
Laurate	13.79	16.01	26.47												
Myristate	12.09	14.30	23.56				9.47	11.13	18.39	6.32	7.46	10.77			
Palmitate	11.01	13.02	21.46	7.55	8.92	14.86							6.63		
Stearate	10.30	11.80	19.56				7.89	9.37	15.09	5.55	6.47	9.71	5.40	6.44	10.55
	β-Heptyl esters												s=Benzene		
Acetate	5.02	5.72	8.13							−8.52	−10.28	−20.96	4.28	4.51	6.98
Propionate	5.71	6.32	9.27							10.91	14.24	28.21	1.26	1.36	2.14
n-Butyrate	8.06	9.26	14.71	−2.13	−2.84	−6.10	−0.65	−0.87	−1.85	7.71	9.74	19.73			
n-Valerate	8.92	9.88	15.72				+0.91	+1.01	+0.39	6.10	8.52	17.71			
Caproate	8.20	9.78	15.10										3.63	4.19	4.65
Enanthate	8.43	10.29	17.18							5.28	6.39	13.70			
Caprylate	8.53	9.82	15.18	−0.40	−0.68	−1.35	1.33	1.54	1.95	4.80	6.63	13.09			
Pelargonate	8.32	8.92	14.25	+0.35	−0.18	−1.42	1.60	1.33	0.36	5.42	7.20	14.16			
Undecylate	7.36	8.25	13.80				1.41	1.50	1.59	4.53	6.04	12.17			
Laurate	7.08	8.11	13.80												
Myristate	6.59	7.19	11.72				1.21	1.43	1.64	3.92	5.26	10.52			
Palmitate	6.19			+0.93											
Stearate	5.90	6.63	10.58	+0.27	+0.27	+0.54	1.04	0.78	−0.27	3.44	4.09	8.50	2.57	2.57	2.92

	β-Octyl esters												s=CS₂		
Acetate	3.28	3.86	5.50	−3.80	−4.83	−10.69	−0.84	−1.12	−3.63	−8.96	−11.45	−22.13	−4.70	−6.60	−14.76
Propionate	3.66	4.94	6.33				−4.01	−4.90	−10.52	11.42	15.36	32.00	7.45	10.10	20.31
n-Butyrate	7.00	8.26	12.72				−1.49	−2.19	−4.29	8.08	10.62	21.13	5.82	7.80	16.54
n-Valerate	7.62	9.39	15.25				.73	1.22	2.92	7.72	10.09	20.35	5.38	7.72	16.34
Caproate	7.61	8.68	13.95							6.61	7.88	17.74	4.01	5.20	11.74
Enanthate	7.87	8.53	14.10	−.90	−1.54	−3.88	±.00	−.51	−2.11	6.36	8.23	17.00	3.79	5.30	12.03
Caprylate	7.27	8.30	13.05												
Pelargonate	7.65	8.54	13.85				+.28	±.00	−1.89	5.80	7.34	15.38	3.41	4.62	10.44
Undecylate	7.40	7.89	13.12							5.18	6.80	13.09	3.03	3.33	10.47
Laurate										4.74	6.16	13.36	2.08	3.12	7.50
Myristate	6.37	7.68	11.62				+1.44	+.96	+.18	4.40	5.62	11.96	2.09	3.22	7.55
Palmitate	6.02	7.04	11.39	±.00	−.39	−2.31	+.27	+.36	+.46	4.32	5.38	11.03			
Stearate	5.27	6.53	10.24	+.27	±.00	−.73	+.32	±.00	−.63	4.49	5.15	10.03	2.43	3.50	5.73

	5,893	5,461	4,358	5,893	5,461	4,358	5,893	5,461	4,358
	β-Undecyl esters								
	s=EtOH			C₆H₆			CS₂		
Acetate	2.32	2.42	2.22	−2.43	−2.91	−6.67	−8.53	−11.10	−21.28
Propionate	2.84	2.99	2.62	−5.32	−6.28	−12.09	11.45	14.52	28.21
n-Butyrate	5.32	5.99	8.79				9.46	11.45	24.72
n-Valerate	5.92	6.92	10.93				8.04	10.30	20.69
Caprylate	6.07	6.86	8.84	−2.07	−3.45	−5.30	7.73	10.18	19.09
Enanthate	6.61	7.05	12.76				6.54	8.60	17.09
Pelargonate	6.60	7.65	11.62	−.87	−1.16	−3.66	5.95	7.66	14.72
Undecylate	5.78	6.41	10.51	−.72	.95	−1.07	5.40	7.08	13.38
Myristate	5.78	6.72	9.98				4.90	6.43	12.48

Esters of—	5,893	5,461	4,358	5,893	5,461	4,358	5,893	5,461	4,358
	Acetates			Laurates			Acetates		
	s=EtOH						CS₂		
Butan-β-ol	25.87	30.45	50.06	13.79	16.01	26.47	15.62	18.31	27.53
Pentan-β-ol	15.41			10.53					
Hexan-β-ol	6.94	7.66	11.64				−4.70	−6.60	−14.76
Heptan-β-ol	5.02	5.72	8.13	7.08	8.11	13.80	−8.52	−10.28	−20.96
Octan-β-ol	3.52	4.15	6.00				−8.96	−11.45	−22.13
Nonan-β-ol	2.73	2.82	3.02	6.47	7.31		−9.13	−12.14	−23.50
Decan-β-ol	2.54	2.62	2.71	6.02			−8.68	−13.60	−22.16
Undecan-β-ol	2.32	2.42	2.22				−8.53	−11.10	−21.28
Dodecan-β-ol				6.01					
Tridecan-β-ol	1.76	1.58	1.32	5.50	6.21		−7.90	−10.00	−19.39

Specific rotation $[a]_\lambda^t$ *of alkyl esters in various solvents (5 per cent concentration)* **(164)**—Continued

t=Room temp. λ=	5,893	5,461	4,358	5,893	5,461	4,358	5,893	5,461	4,358	5,893	5,461	4,358	5,893	5,461	4,358
s=	β-Octyl acetate			β-Octyl stearate			β-Octyl enanthate			β=Octyl hydrogen phthalate			β-Butyl acetate		
None	6.84	8.01	12.45	5.71	6.68		8.59	9.97	16.10				25.43	30.17	49.52
$C_2H_4Br_2$	9.79	11.11	17.42	7.43	8.50	14.50	11.39	13.00	21.76				26.80	31.96	52.84
s–$C_2H_2Cl_4$	5.91	6.84	9.53												
CH_3OCH_3	5.56			5.48	6.52	10.17	9.09	10.16	16.66				25.61	30.31	49.87
CH_3NO_2	5.25	5.83	8.55												
EtOAc	5.18			5.31	5.86	9.68	8.50	9.70	15.89	46.58	55.99	104.4	25.75	30.00	49.20
$CHCl_3$	3.78			4.57	5.11	8.07	7.76	8.68	13.40				25.07	29.56	49.34
AcOH	3.65									40.50	49.08	90.90			
EtOH	3.52	4.15	6.00	5.27	6.53	10.24	7.87	8.53	14.10	48.68	59.51	112.1	25.87	30.45	50.06
CCl_4	3.50														
C_6H_6	−0.84	−1.12	−3.63	0.32	±0.00	−0.63	±0.00	−0.51	−2.11	42.83	52.41	98.72	21.92	26.10	43.73
Phenetole	−1.39														
C_6H_5Cl	−3.10														
Py	−3.80	−4.83	−10.69	0.27	±0.00	−0.73	−0.90	−1.54	−3.88				18.56	21.78	35.16
CS_2	−8.96	−11.45	−22.13	−4.49	−5.15	−10.03	−6.36	−8.23	−17.00	38.11	46.17	88.04	15.62	18.31	27.53

Influence of concentration on rotatory power at laboratory temperature **(164)**

p \ λ	5,893	5,461	4,358	p \ λ	5,893	5,461	4,358	p \ λ	5,893	5,461	4,358
d-β-Butyl acetate s=CS_2				d-β-Octyl acetate s=CS_2				d-β-Octyl acetate s=C_6H_6			
7.56	16.02	18.33	28.15	4.56	−9.11	−10.46	−22.18	9.77	−0.64	−0.88	−2.86
21.40	19.04	22.17	35.52	15.37	−5.14	−6.27	−13.95	29.39	+.49	+.33	−.51
29.87	20.21	23.63	38.23	32.07	−1.07	−1.52	−4.77	46.59	1.69	1.80	1.73
50.15	22.40	26.43	43.21	44.33	+1.15	+1.18	+.05	62.91	3.15	3.54	4.68
66.45	23.84	28.16	46.22	47.90	1.72	1.79	1.27	71.05	3.96	4.44	6.22
100.00	25.43	30.17	49.51	60.85	3.47	3.92	5.06	100.00	7.05	8.22	12.47
				72.49	4.80	5.53	7.85				
				100.00	7.05	8.22	12.47				

Specific rotation $[\alpha]_\lambda^t$ *of esters of acetic acid* **(99)**

λ→	5,893	5,461	4,358	5,893	5,461	4,358	5,893	5,461	4,358	5,893	5,461	4,358	5,893	5,461	4,358	5,893	5,461	4,358
t ↓	$C_8H_{16}O_2$ *d*-γ-Hexyl acetate			$C_9H_{18}O_2$ *d*-γ-Heptyl acetate			$C_{10}H_{20}O_2$ *d*-γ-Octyl acetate			$C_{12}H_{24}O_2$ *l*-γ-Decyl acetate			$C_{13}H_{26}O_2$ *l*-γ-Undecyl acetate			$C_{14}H_{28}O_2$ *l*-γ-Dodecyl acetate		
20	0.55	0.65	0.71	−4.68	−5.66	−10.44	−4.30	−5.08	−9.63	4.48	5.40	9.85	4.40	5.11	9.38	3.68	4.43	8.14
40	.54	.63	.70	−4.73	−5.73	−10.52	−4.37	−5.15	−9.75	4.53	5.44	9.91	4.40	5.14	9.44	3.64	4.38	8.04
60	.52	.61	.68	−4.78	−5.80	−10.63	−4.46	−5.24	−9.88	4.56	5.48	9.96	4.42	5.20	9.49	3.59	4.31	7.98
80	.51	.60	.67	−4.83	−5.88	−10.73	−4.54	−5.34	−10.02	4.62	5.53	10.03	4.45	5.24	9.55	3.57	4.28	7.93
100	.50	.58	.65	−4.88	−5.94	−10.83	−4.61	−5.43	−10.16	4.66	5.57	10.10	4.47	5.28	9.62	3.55	4.24	7.88
120	.48	.56	.63	−4.93	−6.01	−10.95	−4.71	−5.54	−10.30	4.72	5.61	10.20	4.50	5.33	9.69	3.59	4.23	7.89
140	.46	.54	.61	−4.98	−6.08	−11.07	−4.77	−5.63	−10.43	4.77	5.67	10.29	4.53	5.37	9.72	3.63	4.26	7.97
160	-----	-----	-----	−5.03	−6.16	−11.20	−4.86	−5.73	−10.59	4.82	5.70	10.40	4.57	5.35	9.80	3.71	4.28	8.05
180	-----	-----	-----	-----	-----	-----	−4.96	−5.85	−10.79	4.87	5.74	10.49	4.58	5.48	9.88	3.80	4.31	8.19
200	-----	-----	-----	-----	-----	-----	-----	-----	-----	4.92	5.79	10.59	4.59	5.40	9.95	3.85	4.36	8.37
	$C_{15}H_{30}O_2$ *l*-γ-Tridecyl acetate			$C_{16}H_{32}O_2$ *l*-γ-Tetradecyl acetate			$C_{17}H_{34}O_2$ *l*-γ-Pentadecyl acetate			$C_{18}H_{36}O_2$ *l*-γ-Hexadecyl acetate			$C_{20}H_{40}O_2$ *l*-γ-Octadecyl acetate					
20	3.83	4.61	8.49	3.69	4.44	8.17	3.68	4.42	8.08	3.19	3.86	7.20	2.98	3.72	6.63	-----	-----	-----
40	3.86	4.64	8.53	3.70	4.46	8.22	3.67	4.42	8.10	3.21	3.87	7.25	3.01	3.53	6.65	-----	-----	-----
60	3.90	4.69	8.56	3.73	4.49	8.27	3.68	4.43	8.12	3.24	3.89	7.28	3.00	3.53	6.67	-----	-----	-----
80	3.93	4.71	8.60	3.76	4.51	8.33	3.69	4.45	8.15	3.26	3.89	7.30	3.02	3.55	6.71	-----	-----	-----
100	3.97	4.73	8.66	3.79	4.56	8.38	3.70	4.47	8.18	3.31	3.90	7.35	3.05	3.56	6.75	-----	-----	-----
120	4.00	4.75	8.72	3.82	4.58	8.44	3.70	4.49	8.21	3.35	3.91	7.39	3.06	3.58	6.79	-----	-----	-----
140	4.03	4.78	8.78	3.86	4.61	8.52	3.70	4.51	8.23	3.38	3.92	7.44	3.08	3.58	6.85	-----	-----	-----
160	4.08	4.84	8.89	3.91	4.64	8.59	3.71	4.53	8.30	3.40	3.93	7.50	3.11	3.60	6.89	-----	-----	-----
180	4.13	4.91	9.03	3.95	4.68	8.66	3.71	4.52	8.37	3.44	3.97	7.59	3.14	3.63	6.93	-----	-----	-----
200	4.17	4.94	9.14	3.99	4.71	8.75	3.71	4.56	8.40	3.47	4.00	7.69	3.16	3.63	6.99	-----	-----	-----

Specific rotation $[\alpha]_{\lambda}^{20}$ *of alkyl esters in solution* **(99)**

	Acetates						Enanthates					
c=5 per cent s	EtOH			CS₂			EtOH			CS₂		
λ	5,893	5,461	4,358	5,893	5,461	4,358	5,893	5,461	4,358	5,893	5,461	4,358
d-sec-Butyl	25.87	30.45	50.06	15.62	18.31	27.53	18.03	21.15	34.99	8.16	9.53	14.46
γ-Pentyl	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
d-γ-Hexyl	−.34	−.43	−.60	−2.07	−2.34	−3.60	+.08	+.16	+.32	2.07	2.04	5.17
d-γ-Heptyl	−8.01	−8.96	−16.28	−14.96	−18.10	−33.06	−3.19	−3.44	−6.46	−10.64	−12.98	−23.86
d-γ-Octyl	−7.41	−8.69	−15.42	−15.27	−18.32	−33.69	−2.70	−3.15	−5.84	−10.79	−13.33	−21.47
d-γ-Nonyl	−8.12	−9.57	−16.90	−17.89	−21.31	−38.62	−3.67	−4.32	−7.61	−13.40	−16.10	−28.30
l-γ-Decyl	7.24	8.87	15.58	15.28	18.16	34.43	--------	--------	--------	--------	--------	--------
l-γ-Undecyl	7.12	8.45	14.86	14.24	17.13	32.63	--------	--------	--------	--------	--------	--------
l-γ-Dodecyl	6.02	7.42	13.64	13.10	15.44	29.25	--------	--------	--------	--------	--------	--------
l-γ-Tridecyl	6.77	8.19	14.46	14.12	16.90	31.12	−2.40	−2.70	−5.09	−10.50	−12.60	−22.90
l-γ-Tetradecyl	6.69	8.11	14.97	13.92	16.85	31.03	+2.45	−2.94	−5.96	+10.88	+13.25	+24.75
l-γ-Pentadecyl	6.61	8.31	15.08	13.38	16.01	29.84	+2.69	+3.41	+6.20	10.69	13.12	23.81
l-γ-Hexadecyl	6.56	7.60	13.27	12.39	15.20	28.39	2.10	2.54	5.51	10.21	11.98	22.75
l-γ-Octadecyl	5.96	7.06	12.25	11.54	13.59	25.23	1.94	2.31	4.64	8.46	10.14	19.15

[1] Inactive.

Specific rotatory power $[\alpha]_{\lambda}^{t}$ *of d-β-octyl alkyl esters of the dicarboxylic acids* (78)

	$C_{11}H_{20}O_4$ Octyl methyl oxalate			$C_{12}H_{22}O_4$ Octyl ethyl oxalate			$C_{13}H_{24}O_4$ Octyl ethyl malonate			$C_{13}H_{24}O_4$ *l*-β-Octyl methy succinate		
t ↓ λ→	5,893	5,461	4,358	5,893	5,461	4,358	5,893	5,461	4,358	5,893	5,461	4,358
20	14.22	16.64	25.91	13.98	16.33	24.94	9.27	10.83	17.40	−3.54	−3.97	−5.85
40	13.32	15.24	24.25	13.05	15.13	23.56	8.10	9.28	15.19	3.39	3.83	5.62
60	12.72	14.42	22.96	12.54	14.17	22.08	7.36	8.41	13.74	3.30	3.71	5.42
80	12.22	13.77	21.96	12.48	13.72	21.04	6.67	7.73	12.59	3.12	3.56	5.20
100	11.79	13.21	21.01	12.38	13.44	20.08	6.13	7.17	11.61	2.94	3.38	5.00
120	11.39	12.68	20.19	12.37	13.36	19.21	5.66	6.72	10.81	2.77	3.17	4.78

	$C_{14}H_{26}O_4$ Octyl ethyl succinate						$C_{18}H_{34}O_4$ Octyl oxalate			$C_{19}H_{36}O_4$ Octyl malonate					
t ↓ λ→	6,438	5,461	5,086	4,800	4,678	4,358	5,893	5,461	4,358	6,438	5,461	5,086	4,800	4,678	4,358
20	2.44	3.67	3.96	4.37	4.56	5.33	22.72	26.57	40.66	9.19	12.83	14.79	16.37	17.07	19.37
40	2.29	3.48	3.78	4.16	4.37	5.05	21.56	24.93	38.77	8.08	11.33	12.88	14.23	14.89	16.62
60	2.25	3.39	3.65	3.98	4.19	4.82	20.60	23.72	37.15	7.09	10.18	11.44	12.68	13.40	14.60
80	2.20	3.35	3.59	3.88	4.10	4.69	19.86	22.83	35.96	6.42	9.17	10.24	11.39	12.08	13.11
100	2.20	3.30	3.55	3.79	4.02	4.62	19.32	22.26	34.92	5.95	8.40	9.33	10.29	10.98	11.90
120	2.20	3.30	3.53	3.75	3.96	4.58	18.98	21.77	34.00	5.51	7.76	8.62	9.43	10.09	10.92

	$C_{20}H_{38}O_4$ Octyl succinate						$C_{21}H_{40}O_4$ Octyl glutarate						$C_{22}H_{42}O_4$ Octyl adipate		
	6,438	5,461	5,086	4,800	4,678	4,358	6,438	5,461	5,086	4,800	4,678	4,358	5,893	5,461	4,358
20	4.08	5.54	6.00	6.65	7.02	7.63	7.12	10.35	11.63	12.77	13.39	15.35	11.23	12.66	19.93
40	3.93	5.32	5.77	6.39	6.70	7.23	6.33	9.18	10.17	11.14	11.89	13.40	10.42	11.64	18.34
60	3.77	5.21	5.60	6.21	6.50	7.00	5.70	8.25	9.06	9.95	10.60	11.93	9.55	10.69	16.93
80	3.63	5.10	5.49	6.04	6.36	6.82	5.22	7.47	8.28	9.04	9.61	10.99	8.69	9.81	15.52
100	3.55	5.05	5.45	5.96	6.22	6.69	4.87	6.91	7.72	8.43	8.96	10.25	7.90	9.01	14.23
120	3.53	5.03	5.43	5.91	6.12	6.41	4.60	6.46	7.20	7.99	8.47	9.59	7.19	8.23	13.17

Specific rotatory power $\left[\alpha\right]_{\lambda}^{t}$ *of d-β-octyl alkyl esters of the dicarboxylic acids* (78)—Continued

	$C_{23}H_{44}O_4$ Octyl pimelate						$C_{24}H_{46}O_4$ Octyl suberate			$C_{25}H_{48}O_4$ Octyl azelate					
t ↓ λ→	6,438	5,461	5,086	4,800	4,678	4,358	5,893	5,461	4,358	6,438	5,461	5,086	4,800	4,678	4,358
20	9.53	13.18	15.33	17.22	18.25	20.64	11.01	12.95	19.59	9.02	12.76	14.69	16.36	17.10	19.54
40	8.49	11.52	13.34	14.10	16.10	17.94	9.89	11.59	17.97	8.37	11.58	13.51	14.99	15.60	17.59
60	7.72	10.31	11.83	13.39	14.16	15.91	8.85	10.47	16.77	7.75	10.68	12.36	13.69	14.23	16.12
80	7.13	9.42	10.80	12.28	12.99	14.40	8.03	9.54	15.79	7.16	9.85	11.33	12.57	13.07	14.84
100	6.76	8.83	10.14	11.62	12.21	13.48	7.35	8.95	14.84	6.64	9.17	10.40	11.50	12.01	13.84
120	6.53	8.44	9.66	11.26	11.79	12.94	6.85	8.46	13.88	6.23	8.58	9.59	10.60	11.05	12.93

	$C_{26}H_{50}O_4$ Octyl sebacate						$C_{27}H_{52}O_4$ Octyl *n*-nonane-*i*-dicarboxylate			$C_{28}H_{54}O_4$ Octyl *n*-decane-*k*-dicarboxylate			$C_{29}H_{56}O_4$ Octyl *n*-undecane-dicarboxylate		
	6,438	5,461	5,086	4,800	4,678	4,358	5,893	5,461	4,358	5,893	5,461	4,358	5,893	5,461	4,358
20	8.45	12.04	14.16	15.80	16.75	18.87	10.37	11.77	18.30	10.36	11.29	16.98	9.25	11.12	17.47
40	7.64	10.84	12.75	14.03	14.86	16.86	9.39	10.54	16.05	9.25	10.22	15.37	8.77	10.35	16.02
60	6.95	9.76	11.43	12.48	13.35	15.04	8.63	9.66	14.65	8.42	9.40	14.32	8.48	9.75	14.79
80	6.39	8.83	10.36	11.29	12.08	13.51	7.84	8.87	13.43	7.67	8.70	13.42	8.27	9.33	13.78
100	5.95	8.03	8.40	10.34	11.10	12.26	7.08	8.05	12.33	7.02	8.02	12.56	8.02	8.95	12.83
120	5.62	7.45	8.72	9.61	10.31	11.29	6.29	7.18	11.27	6.52	7.44	11.70	7.89	8.74	11.99

Specific rotatory power $[\alpha]^t_\lambda$ *of the preceding esters in approximately 5 per cent solution*

Esters	s=Ethyl alcohol					Carbon disulphide				
	c	*t*	5,893	5,461	4,358	*c*	*t*	5,893	5,461	4,358
d-β-$C_{11}H_{20}O_4$	4.95	20	13.14	16.28	24.36	4.57	20	11.48	12.47	18.27
d-β-$C_{12}H_{22}O_4$	4.99	18	13.61	18.03	25.64	5.01	18	9.98	12.08	18.47
d-β-$C_{13}H_{24}O_4$ malonate	5.04	21	7.34	8.14	13.70	5.06	19.5	−5.04	−7.01	−14.62
l-β-$C_{13}H_{24}O_4$ succinate	5.05	20	−1.29	−2.18	−2.97	5.06	20	12.66	16.02	31.54
d-β-$C_{14}H_{26}O_4$	5.07	18	1.87	2.66	4.73	4.99	17	−13.34	−14.94	−31.09
d-β-$C_{18}H_{34}O_4$	4.99	18	23.73	27.54	43.66	4.97	16	10.37	13.79	17.22
d-β-$C_{19}H_{36}O_4$	5.04	18	9.63	10.52	16.97	4.99	17	−13.13	−15.14	−30.17
d-β-$C_{20}H_{38}O_4$	5.10	18	1.77	1.67	−.29	5.03	17	−21.18	−24.97	−49.82
d-β-$C_{21}H_{40}O_4$	5.07	18	8.39	9.48	14.51	5.05	17	−11.69	−13.67	−27.33
d-β-$C_{22}H_{42}O_4$	5.03	18	9.45	10.35	16.72	5.11	17	−10.95	−13.10	−26.70
d-β-$C_{23}H_{44}O_4$	5.04	18	9.43	11.03	17.98	5.09	18	−8.85	−11.90	−22.81
d-β-$C_{24}H_{46}O_4$	5.03	19	8.95	10.74	17.70	5.01	18	−9.59	−11.29	−20.48
d-β-$C_{25}H_{48}O_4$	5.15	19	9.22	10.86	16.11	5.03	18	−7.86	−9.75	−20.19
d-β-$C_{26}H_{50}O_4$	5.00	18	8.71	10.41	16.81	4.96	18	−8.06	−10.28	−20.34
d-β-$C_{27}H_{52}O_4$	5.04	18	8.93	10.12	16.36	4.97	18	−7.75	−9.46	−20.22
d-β-$C_{28}H_{54}O_4$	5.01	19	9.29	9.98	16.58	4.97	18	−7.65	−9.36	−18.94
d-β-$C_{29}H_{56}O_4$	4.62	19	9.41	10.06	15.15	4.71	18	−6.26	−7.85	−15.50

Alkylisopropylcarbinyl hydrogen phthalates (162)	$CHCl_3$ *c*=5		EtOH *c*=5	
	$[\alpha]_D$	$[M]_D$	$[\alpha]_D$	$[M]_D$
$C_{13}H_{16}O_4$ *d*-Methyl[1]	37.9	89.3	41.4	97.7
$C_{14}H_{18}O_4$ *d*-Ethyl[1]	−.5	−1.2	−4.0	−10.1
$C_{15}H_{20}O_4$ *d*-Propyl	−7.8	20.9	8.4	22.1
$C_{15}H_{20}O_4$ *l*-*n*-Propyl	−7.8	----------	−8.0	----------
$C_{16}H_{22}O_4$ *d*-*n*-Butyl	13.9	38.7	12.8	35.5
$C_{16}H_{22}O_4$ *l*-*n*-Butyl	−13.8	----------	−12.9	----------
$C_{17}H_{24}O_4$ *d*-*n*-Amyl	13.5	39.3	15.1	44.1
$C_{18}H_{26}O_4$ *d*-*n*-Hexyl	11.8	36.1	17.0	52.1
$C_{20}H_{30}O_4$ *d*-*n*-Octyl	16.9	56.3	17.2	57.3
$C_{22}H_{24}O_4$ *d*-*n*-Decyl	13.9	50.3	16.8	61.0

[1] Not recrystallized, being very soluble in organic media.

α, β-*Dichloropropionates*[1] (67)

$C_4H_6Cl_2O_2$ Methyl		$C_5H_8Cl_2O_2$ Ethyl		$C_7H_{12}Cl_2O_2$ Isobutyl		$C_{10}H_{18}Cl_2O_2$ Heptyl	
t	$[\alpha]_D$	*t*	$[\alpha]_D$	*t*	$[\alpha]_D$	*t*	$[\alpha]_D$
3.5	0.95	12.0	−1.96	14.5	−3.73	12.0	−1.84
13.5	1.47	20.0	−1.79	20.0	−3.62	20.0	−1.73
20.0	1.70	39.5	−1.40	40.5	−3.31	40.0	−1.62
43.5	2.35	56.5	−.97	68.0	−2.91	53.0	−1.54
54.5	2.54	----------	----------	----------	----------	99.0	−1.26

[1] Prepared from corresponding *l*-glycerates, possibly partly racemized.

Specific rotation $[\alpha]_\lambda^t$ *of d-γ-nonyl esters* **(99, 166)**

t ↓ λ→	5,893	5,461	4,358	5,893	5,461	4,358	5,893	5,461	4,358	5,893	5,461	4,358	5,893	5,461	4,358
	$C_{10}H_{20}O_2$ Formate			$C_{11}H_{22}O_2$ Acetate			$C_{12}H_{24}O_2$ Propionate			$C_{13}H_{26}O_2$ *n*-Butyrate			$C_{14}H_{28}O_2$ Valerate		
20	−11.28	−13.47	−23.48	−5.21	−6.27	−11.47	−5.87	−7.00	−12.55	−3.38	−4.11	−7.59	−3.12	−3.85	−7.18
40	−11.27	−13.36	−23.42	−5.21	−6.29	−11.43	−5.67	−6.81	−12.27	−3.31	−4.05	−7.54	−3.01	−3.78	−6.96
60	−11.26	−13.24	−23.42	−5.25	−6.34	−11.47	−5.53	−6.67	−12.03	−3.27	−4.00	−7.49	−2.91	−3.68	−6.79
80	−11.24	−13.13	−23.52	−5.26	−6.39	−11.56	−5.43	−6.58	−11.85	−3.22	−3.96	−7.43	−2.82	−3.57	−6.60
100	−11.23	−13.11	−23.72	−5.33	−6.43	−11.68	−5.36	−6.51	−11.70	−3.20	−3.92	−7.39	−2.73	−3.45	−6.41
120	−11.25	−13.26	−24.08	−5.39	−6.58	−11.79	−5.35	−6.40	−11.54	−3.15	−3.88	−7.34	−2.63	−3.32	−6.19
140				−5.47	−6.64	−11.88	−5.30	−6.39	−11.39	−3.11	−3.83	−7.27	−2.56	−3.20	−6.00
160				−5.51	−6.67	−11.98	−5.28	−6.42	−11.27	−3.06	−3.76	−7.21	−2.49	−3.09	−5.78
180										−3.01	−3.70	−7.13	−2.41	−2.96	−5.55
200										−2.95	−3.62	−7.09	−2.33	−2.80	−5.31
	$C_{15}H_{30}O_2$ Caproate			$C_{16}H_{32}O_2$ Enanthate			$C_{17}H_{34}O_2$ Caprylate			$C_{18}H_{36}O_2$ Pelargonate			$C_{19}H_{38}O_2$ Caprate		
20	−2.66	−3.33	−6.23	−2.36	−2.91	−5.62	−2.10	−2.54	−4.94	−1.94	−2.45	−4.59	−1.90	−2.44	−4.38
40	−2.56	−3.21	−6.04	−2.26	−2.82	−5.39	−2.02	−2.50	−4.81	−1.84	−2.38	−4.46	−1.84	−2.38	−4.28
60	−2.43	−3.12	−5.82	−2.18	−2.70	−5.16	−1.94	−2.42	−4.66	−1.76	−2.29	−4.33	−1.78	−2.31	−4.18
80	−2.35	−3.03	−5.62	−2.10	−2.59	−4.95	−1.85	−2.35	−4.54	−1.68	−2.22	−4.21	−1.73	−2.24	−4.07
100	−2.24	−2.90	−5.45	−2.02	−2.50	−4.79	−1.76	−2.28	−4.39	−1.59	−2.11	−4.08	−1.66	−2.16	−3.96
120	−2.16	−2.80	−5.26	−1.93	−2.39	−4.59	−1.66	−2.20	−4.24	−1.48	−2.02	−3.94	−1.57	−2.05	−3.84
140	−2.09	−2.69	−5.06	−1.84	−2.30	−4.42	−1.55	−2.12	−4.06	−1.37	−1.93	−3.79	−1.50	−1.96	−3.72
160	−2.02	−2.55	−4.90	−1.76	−2.19	−4.23	−1.43	−2.03	−3.91	−1.26	−1.83	−3.66	−1.41	−1.86	−3.60
180	−1.95	−2.44	−4.70	−1.68	−2.09	−4.09	−1.33	−1.95	−3.73	−1.15	−1.74	−3.49	−1.32	−1.77	−3.46
200	−1.88	−2.31	−4.56	−1.59	−2.01	−3.96	−1.20	−1.87	−3.56	−1.04	−1.63	−3.31	−1.25	−1.66	−3.33
	$C_{20}H_{42}O_2$ Undecylate			$C_{21}H_{42}O_2$ Laurate			$C_{23}H_{46}O_2$ Myristate			$C_{25}H_{50}O_2$ Palmitate			$C_{27}H_{54}O_2$ Stearate		
20	−1.83	−2.28	−4.33	−1.63	−2.08	−3.85	−1.55	−2.01	−3.74	−1.49	−1.86	−3.34	−1.49	−1.78	−3.17
40	−1.79	−2.24	−4.25	−1.55	−1.99	−3.71	−1.51	−1.94	−3.61	−1.46	−1.80	−3.27	−1.46	−1.74	−3.08
60	−1.76	−2.19	−4.12	−1.48	−1.93	−3.57	−1.47	−1.87	−3.46	−1.43	−1.75	−3.20	−1.43	−1.71	−3.00
80	−1.70	−2.11	−3.91	−1.41	−1.84	−3.43	−1.43	−1.81	−3.34	−1.39	−1.67	−3.11	−1.39	−1.67	−2.92
100	−1.61	−2.01	−3.71	−1.34	−1.75	−3.27	−1.34	−1.73	−3.19	−1.34	−1.60	−3.00	−1.34	−1.62	−2.85
120	−1.51	−1.89	−3.46	−1.27	−1.68	−3.12	−1.27	−1.64	−3.03	−1.30	−1.55	−2.93	−1.30	−1.59	−2.76
140	−1.42	−1.80	−3.29	−1.21	−1.59	−2.94	−1.21	−1.56	−2.87	−1.23	−1.49	−2.82	−1.25	−1.53	−2.65
160	−1.33	−1.69	−3.08	−1.12	−1.49	−2.77	−1.15	−1.48	−2.71	−1.16	−1.39	−2.71	−1.20	−1.46	−2.57
180	−1.22	−1.59	−2.87	−.99	−1.39	−2.58	−1.08	−1.39	−2.54	−1.08	−1.28	−2.57	−1.14	−1.41	−2.46
200	−1.11	−1.45	−2.63	−.96	−1.29	−2.39	−.99	−1.28	−2.34	−1.96	−.17	−2.45	−1.10	−1.37	−2.37

Specific rotation $[\alpha]_{\lambda}^{t}$ *of d-γ-nonyl esters in solution* (**99**)

t=Temperature of laboratory

Ester	c	Ethyl alcohol			c	Carbon disulphide		
	λ=	5,893	5,461	4,358	λ=	5,893	5,461	4,358
Acetate	4.495	−8.12	−9.57	−16.90	5.115	−17.89	−21.31	−38.62
Propionate	5.240	−8.77	−20.68	−17.97	5.430	−20.72	−25.59	−44.01
n-Butyrate	5.195	−5.69	−6.65	−11.55	5.175	−17.10	−24.80	−36.74
n-Valerate	5.095	−4.91	−5.59	−9.61	5.050	−15.36	−19.42	−34.48
Caproate	4.885	−4.19	−4.93	−8.84	5.255	−14.55	−17.51	−31.49
Enanthate	5.170	−3.67	−4.32	−7.61	5.005	−13.40	−16.10	−28.30
Caprylate	5.035	−3.07	−3.52	−6.05	5.435	−12.51	−15.37	−26.22
Pelargonate	5.260	−2.76	−3.48	−5.42	5.295	−11.90	−14.73	−24.93
Caprate	5.720	−2.62	−3.32	−6.03	5.720	−10.75	−13.63	−24.04
Undecylate	5.440	−2.42	−2.84	−5.26	5.745	−10.35	−12.61	−23.31
Laurate	5.090	−2.36	−2.86	−4.47	4.995	−10.30	−12.51	−22.02
Myristate	--------	−2.31	−2.48	−3.85	4.925	−9.75	−11.68	−20.31
Palmitate	4.735	−2.40	−2.69	−3.36	5.140	−9.15	−10.51	−18.78
Stearate	4.755	−2.30	−2.49	−3.33	5.245	−8.67	−10.49	−17.93

Specific rotation of d-γ-nonyl acetate (**99**)

Py	4.820	−13.39	−16.08	25.72	--------	--------	--------	--------
C_6H_6	4.831	−12.42	−14.87	25.50	--------	--------	--------	--------
$CHCl_3$	4.615	−8.73	−9.55	16.25	--------	--------	--------	--------
AcOEt	4.996	−5.91	−7.00	12.21	--------	--------	--------	--------
Me_2CO	4.684	−6.08	−7.15	12.06	--------	--------	--------	--------
$C_2H_4Br_2$	4.898	−3.74	−4.49	8.13	--------	--------	--------	--------

$C_4H_8O_3$ Methyl *l*-lactate (**148**; *cf.*, **66**, **221**)					
(**66**; *cf.*, **221**)		s=$PhNO_2$		$C_2H_2Cl_4$	
t	$[\alpha]_D^t$	t	$[\alpha]_D^t$	t	$[\alpha]_D^t$
−75.0	5.48	$p=9.877$ 16.0	9.85	$p=9.937$ −7.8	−7.66
−51.0	5.84	36.2	9.90	39.7	−2.53
16.7	8.10	56.5	10.16	94.3	1.96
35.4	8.68	104.5	10.63	120.0	3.74
78.8	9.98	141.0	10.95	--------	--------
125.0	11.13	--------	--------	--------	--------
$C_6H_{10}O_4$ Methyl *l*-α-acetoxypropionate					
−7.4	54.26	$p=10.14$ 0.3	59.78	$p=10.035$ 17.6	47.56
43.0	54.20	19.2	57.20	54.7	47.32
83.2	54.03	65.0	52.77	91.3	47.34
141.0	54.08	141.0	50.88	139.3	47.80
$C_5H_{10}O_3$ Methyl *l*-α-methoxypropionate					
−16.6	103.3	$p=9.802$ 16.6	88.82	$p=10.062$ 16.7	73.69
16.4	97.16	41.7	85.27	39.8	72.52
51.1	91.81	70.5	82.17	77.0	70.52
78.4	88.28	92.8	79.25	101.0	69.40
130.0	84.16	119.0	76.40	119.0	68.21

Esters of methylbenzyl carbinol in various solvents (5 per cent solution) at laboratory temperature **(101)**

		s=EtOH					CS_2			
Ester	$\overset{c}{\downarrow}\,\lambda\rightarrow$	5,893	5,700	5,461	4,358	$\overset{c}{\downarrow}\,\lambda\rightarrow$	5,893	5,700	5,461	4,358
Acetate	5.805	8.01	8.61	9.47	15.72	5.060	−8.17	−8.36	−10.42	−22.55
Propionate	5.315	7.24	7.62	8.56	14.11	5.165	−13.78	−14.62	−16.85	−34.57
Butyrate	5.145	12.14	12.74	14.48	24.01	5.405	−7.77	−8.42	−9.17	−22.29
Valerate	5.630	14.70	15.75	17.20	29.23	3.645	−4.61	−4.86	−6.11	−14.21
Caproate	5.605	14.55	15.53	16.96	28.57	5.020	−3.26	−3.98	−4.62	−10.95
Enanthate	5.240	15.09	15.38	17.67	29.98	5.040	−1.80	−2.25	−2.80	−8.12
Caprylate	5.360	14.66	15.03	17.18	29.32	5.540	−.90	−.98	−1.15	−5.57
Pelargonate	5.550	14.34	15.24	17.50	28.85	5.500	−.36	−.45	−.73	−4.45
Caprate	5.525	14.32	15.13	16.93	28.72	5.450	−.33	−.50	−1.00	−3.92
Undecylate	5.250	13.61	14.19	16.19	27.71	5.270	.00	−.19	−.28	−3.51
Laurate	5.180	13.02	13.50	15.71	26.23	5.560	.08	−.08	−.33	−2.70
Myristate	5.455	12.28	13.20	14.48	24.75	5.255	.26	.00	−.17	−1.82
Palmitate	5.425	11.25	11.98	13.55	23.23	5.270	.38	.19	−.09	−1.71
Stearate	5.025	10.45	10.95	12.74	21.19	5.915	.54	.31	.23	−1.31

Specific rotation $[\alpha]_{\lambda}^{t}$ *of esters of methylbenzyl carbinol* **(101)**

λ→	5,893	5,700	5,461	4,358	5,893	5,700	5,461	4,358	5,893	5,700	5,461	4,358	5,893	5,700	5,461	4,358
t ↓	$C_{11}H_{14}O_2$ Acetate				$C_{12}H_{16}O_2$ Propionate				$C_{13}H_{18}O_2$ *n*-Butyrate				$C_{14}H_{20}O_2$ *n*-Valerate			
20	6.41	6.71	7.54	12.12	4.81	5.06	5.58	8.69	8.48	8.94	10.14	16.41	10.76	11.28	12.79	21.19
40	5.27	5.49	6.11	9.64	3.89	4.09	4.47	6.76	7.57	7.95	8.93	14.53	9.94	10.39	11.69	19.53
60	4.10	4.30	4.78	7.32	3.04	3.25	3.50	5.14	6.92	7.24	8.14	13.21	9.13	9.52	10.58	17.70
80	3.05	3.27	3.71	5.45	2.33	2.51	2.67	3.79	6.40	6.70	7.53	12.04	8.48	8.89	9.84	16.42
100	2.31	2.44	2.76	3.78	1.83	1.96	2.13	2.73	6.00	6.30	7.01	11.04	7.97	8.34	9.28	15.29
120	1.56	1.65	1.76	2.18	1.48	1.56	1.65	1.96	5.54	6.80	6.49	10.06	7.59	7.75	8.75	14.16
140	.92	.90	.92	.87	1.20	1.20	1.20	1.20	5.22	5.41	6.04	9.30	7.08	7.31	8.21	13.11
160	.38	.26	.17	−.37	.99	.93	.87	.58	4.96	5.14	5.76	8.77	6.75	6.89	7.90	12.56
180	−.06	−.15	−.27	−1.47	.83	.72	.66	±.00	4.87	4.96	5.56	8.29	6.75	6.96	7.86	12.30
200	−.37	−.56	−.67	−2.18	.73	.67	.49	−.48	4.91	5.03	5.56	7.99	6.82	7.04	7.90	12.44
	$C_{15}H_{22}O_2$ Caproate				$C_{16}H_{24}O_2$ Enanthate				$C_{17}H_{26}O_2$ Caprylate				$C_{18}H_{28}O_2$ Pelargonate			
20	10.46	11.21	12.46	20.91	10.69	11.34	12.72	21.26	10.67	11.36	12.76	21.42	10.50	10.96	12.41	20.90
40	9.58	10.20	11.41	18.84	9.98	10.45	11.80	19.53	9.85	10.53	11.86	19.95	9.84	10.34	11.65	19.63
60	8.88	9.45	10.62	17.34	9.33	9.76	11.03	18.28	9.20	9.81	11.00	18.49	9.16	9.64	10.85	18.22
80	8.46	8.82	10.01	16.31	8.86	9.21	10.32	17.00	8.69	9.25	10.42	17.31	8.62	8.99	10.22	17.05
100	8.09	8.43	9.55	15.54	8.39	8.69	9.69	15.90	8.14	8.76	9.82	16.30	8.21	8.49	9.61	16.08
120	7.77	8.13	9.16	14.89	8.00	8.29	9.19	15.11	7.74	8.27	9.34	15.42	8.00	8.21	9.26	15.38
140	7.47	7.79	8.76	14.19	7.62	7.92	8.82	14.60	7.59	8.00	8.97	14.90	7.77	8.01	8.96	14.71
160	7.18	7.50	8.31	13.55	7.31	7.63	8.48	14.10	7.44	7.82	8.72	14.40	7.56	7.80	8.71	14.17
180	7.05	7.29	8.02	13.06	7.10	7.46	8.26	13.60	7.31	7.67	8.46	14.02	7.28	7.56	8.38	13.61
200	6.95	7.19	7.88	12.66	7.08	7.39	8.17	13.14	7.26	7.67	8.30	13.83	7.04	7.23	8.08	13.17

Specific rotation $[\alpha]_{\lambda}^{t}$ *of esters of methylbenzyl carbinol* **(101)**

λ→	5,893	5,700	5,461	4,358	5,893	5,700	5,461	4,385	5,893	5,700	5,461	4,358	5,893	5,700	5,461	4.358
t ↓	$C_{19}H_{30}O_2$ Caprate				$C_{20}H_{32}O_2$ Undecylate				$C_{21}H_{34}O_2$ Laurate				$C_{24}H_{38}O_2$ Myristate			
20	10.13	10.74	12.20	20.31	9.92	10.51	11.81	20.01	9.66	10.11	11.38	19.39	9.22	9.68	11.28	19.25
40	9.44	10.10	11.47	19.11	9.31	9.90	11.19	18.69	9.11	9.44	10.60	18.04	8.52	9.06	10.17	17.18
60	8.81	9.50	10.88	17.92	8.80	9.26	10.48	17.39	8.45	8.84	9.96	16.80	7.99	8.19	9.23	15.63
80	8.23	8.85	10.21	16.76	8.23	8.73	9.69	16.36	8.02	8.37	9.39	15.90	7.55	7.94	8.78	14.76
100	7.78	8.32	9.55	15.63	7.76	8.30	9.16	15.51	7.55	7.88	8.90	15.13	7.19	7.51	8.50	13.99
120	7.43	7.92	9.04	14.79	7.37	7.84	8.80	14.79	7.17	7.49	8.44	14.28	6.88	7.22	8.17	13.40
140	7.27	7.63	8.70	14.30	7.03	7.48	8.40	14.08	6.85	7.15	8.11	13.54	6.54	6.90	7.82	12.85
160	7.20	7.53	8.49	13.90	6.81	7.18	8.07	13.53	6.60	6.89	7.82	12.84	6.27	6.55	7.48	12.24
180	7.18	7.46	8.29	13.61	6.69	7.06	7.93	12.94	6.45	6.61	7.58	12.40	5.98	6.22	7.14	11.76
200	7.19	7.44	8.27	13.46	6.69	7.07	7.83	12.76	6.30	6.48	7.30	12.13	5.75	6.01	6.90	11.23
	$C_{25}H_{42}O_2$ Palmitate				$C_{27}H_{46}O_2$ Stearate				$C_{11}H_{14}O_2$ *d*-Methylbenzylcarbinyl acetate							
									s			*c*	5,893	5,700	5,461	4,358
20	8.44	9.04	10.04	17.10	7.92	8.37	9.44	15.99								
40	8.01	8.35	9.36	16.04	7.37	7.78	8.62	14.72								
60	7.55	7.87	8.75	15.00	6.95	7.26	7.99	13.59								
80	7.02	7.31	8.23	13.81	6.47	6.71	7.62	12.68	C_6H_6			5.220	8.88	9.49	10.19	18.20
100	6.60	6.89	7.74	13.05	6.11	6.40	7.27	12.10	$CHCl_3$			5.700	8.42	9.12	10.00	17.02
									EtOH			5.805	8.01	8.61	9.47	15.72
120	6.31	6.60	7.35	12.32	5.82	6.12	6.92	11.49	AcOEt			5.615	7.39	7.75	8.91	14.42
140	6.03	6.33	6.97	11.74	5.61	5.84	6.71	11.05	Py			5.850	−1.62	−1.62	−2.05	−4.70
160	5.80	6.10	6.73	11.36	5.44	5.72	6.46	10.69	CS_2			5.060	−8.17	−8.63	−10.42	−22.55
180	5.66	5.85	6.51	11.12	5.32	5.57	6.38	10.59								
200	5.52	5.73	6.28	11.09	5.30	5.59	6.43	10.66								

Specific rotation $\left[\alpha\right]_{\lambda}^{t}$ *of homologous esters of d-α-naphthyl-n-hexyl carbinol* **(102)**

λ→	$C_{19}H_{24}O_2$ Acetate				$C_{20}H_{26}O_2$ Propionate				$C_{21}H_{28}O_2$ *n*-Butyrate				$C_{22}H_{30}O_2$ *n*-Valerate			
t ↓	5,893	5,700	5,461	4,358	5,893	5,700	5,461	4,358	5,893	5,700	5,461	4,358	5,893	5,700	5,461	4,358
20	23.85	25.05	28.68	53.16	28.59	30.18	34.69	64.36	27.02	28.16	32.54	60.22	22.23	23.30	26.73	49.45
40	28.15	29.56	34.07	63.16	33.93	34.43	39.94	74.03	30.71	32.15	37.16	69.34	25.42	26.65	30.71	57.68
60	32.12	33.50	38.73	71.58	36.65	38.13	44.39	83.01	33.71	35.44	41.00	76.68	28.19	29.53	34.09	64.30
80	35.10	36.89	42.48	79.18	39.62	41.28	47.92	89.76	36.02	37.86	44.11	81.93	30.47	31.84	36.74	69.00
100	37.75	39.51	45.50	84.78	42.07	43.96	50.76	95.54	37.87	39.77	46.15	86.24	32.18	33.67	38.89	72.69
120	39.64	41.78	48.09	89.41	43.82	45.73	52.91	99.40	39.13	41.22	47.69	89.02	33.47	35.10	40.52	75.88
140	41.20	43.44	50.03	93.07	45.17	47.20	54.70	102.7	40.17	42.27	48.84	91.49	34.45	36.08	41.73	78.11
160	42.35	44.42	51.39	95.45	46.24	48.35	56.19	105.1	41.04	43.11	49.82	93.42	35.11	36.73	42.48	79.50
180	43.10	44.82	51.84	97.12	47.08	49.12	57.03	107.0	41.66	43.75	50.46	94.58	35.51	37.15	42.94	80.52
200	43.34	44.84	51.40	97.90	47.75	49.71	57.51	108.1	42.01	44.10	50.71	94.99	35.69	37.33	43.04	81.08

	$C_{23}H_{32}O_2$ Caproate			$C_{24}H_{34}O_2$ Enanthate			$C_{25}H_{36}O_2$ Caprylate				$C_{26}H_{38}O_2$ Pelargonate			$C_{27}H_{40}O_2$ Caprate		
	5,893	5,700	5,461	5,893	5,700	5,461	5,893	5,700	5,461	4,358	5,893	5,700	5,461	5,893	5,700	5,461
20	21.12	22.36	--------	19.63	20.59	23.68	21.13	22.11	25.46	47.56	19.06	19.68	22.88	17.13	18.09	20.80
40	23.79	25.10	--------	21.97	23.31	26.46	23.44	24.67	28.39	53.27	21.25	21.82	25.22	18.89	19.82	22.88
60	26.35	27.76	--------	24.11	25.31	28.77	25.23	26.57	30.61	57.44	22.80	23.45	27.16	20.45	21.25	24.55
80	27.94	29.53	--------	25.74	26.85	30.56	26.44	27.93	32.15	60.49	23.82	24.61	28.52	21.65	22.45	25.92
100	29.34	31.06	--------	26.83	28.03	31.96	27.36	28.85	33.19	62.38	24.57	25.46	29.58	22.56	23.42	27.02
120	30.37	32.16	--------	27.50	28.82	33.03	28.05	29.47	33.91	63.57	25.15	26.22	30.42	23.18	24.08	27.86
140	31.27	33.05	37.74	28.02	29.39	33.76	28.49	29.88	34.44	64.63	25.60	26.77	30.99	23.69	24.58	28.44
160	32.02	33.76	38.59	28.54	29.96	34.39	28.75	30.14	34.81	65.69	25.88	27.05	31.34	24.08	25.04	28.95
180	32.62	34.46	39.39	29.05	30.51	35.50	28.29	30.34	35.03	66.70	26.03	27.14	31.48	--------	--------	--------

$C_{28}H_{42}O_2$ Undecylate	
t	5,893
20	16.44
40	18.17
60	19.63
80	20.65
100	21.35
120	21.78
t	5,700
20	17.08
40	18.79
60	20.24
80	21.29
100	22.04
120	22.48
t	5,461
20	19.76
40	21.97
60	23.28
80	24.22
100	25.02
120	25.55

Specific rotation of the above esters in 5 per cent solutions at room temperature

d-α-Naphthyl-n-hexyl carbinyl	s=EtOH				CS_2 (102)			
	5,893	5,700	5,461	4,358	5,893	5,700	5,461	4,358
Acetate	33.80	35.38	40.84	75.88	111.5	117.3	137.0	268.2
Propionate	36.31	37.88	43.88	80.52	122.8	129.1	150.7	293.6
n-Butyrate	32.18	33.66	38.77	71.76	113.1	119.5	139.3	273.2
n-Valerate	27.21	29.32	33.01	61.80	102.7	108.1	126.6	247.3
Caproate	26.52	27.33	31.23	59.89	99.10	102.7	119.8	240.4
Enanthate	23.26	24.68	27.91	51.58	89.74	94.99	110.3	217.4
Caprylate	25.27	26.27	30.16	56.76	86.64	91.07	106.2	207.9
Pelargonate	22.01	22.87	26.32	49.53	84.06	88.54	104.6	203.8
Caprate	19.54	20.64	23.00	--------	78.36	82.35	96.20	199.6
Undecylate	17.99	18.88	21.46	42.74	74.22	78.05	90.99	183.1

	$C_{25}H_{26}O_4$ hydrogen phthalic ester in various solvents (102)			$C_{25}H_{25}O_4Na$ sodium phthalic ester in EtOH (102)		
	t=room temperature			c=5 g in 100 cc		
	5,893	5,461	4,358	5,893	5,461	4,358
CS_2	75.26	90.72	170.0	29.35	35.52	63.24
AcOH	25.25	29.66	47.94	--------	--------	--------
$CHCl_3$	17.50	20.80	32.38	--------	--------	--------
C_6H_6	5.00	4.74	1.00	--------	--------	--------
Py	−1.30	−3.13	−11.14	--------	--------	--------
EtOH	−22.46	−28.63	−61.02	--------	--------	--------

Specific rotation of $C_{14}H_{14}O_2$ l-methyl-α-naphthyl carbinyl acetate

t	5,893	5,461	4,358
20	−32.28	−38.90	−73.79
40	39.51	47.47	88.04
60	44.58	54.04	101.51
80	49.18	59.39	113.02
100	52.85	64.21	121.57
120	55.22	67.07	126.02
140	56.78	68.68	129.82
160	58.11	70.33	132.62
180	59.29	71.83	135.39
l-methyl-α-naphthyl carbinyl hydrogen phthalate (102, 165)			
Approximately 5 per cent solutions at room temperature			
s ↓ λ→	5,893	5,461	4,358
$CHCl_3$	−43.67	−53.47	−109.6
EtOH	−69.68	−84.80	−171.7

Specific rotation $[\alpha]_\lambda^t$ *of esters of benzoic and naphthoic acids with secondary alcohols* **(105)**

t	5,893	5,700	5,461	4,358	5,893	5,700	5,461	4,358	5,893	5,700	5,461	4,358	5,893	5,700	5,461	4,358
	$C_{11}H_{14}O_2$ *d-β*-Butyl benzoate				$C_{13}H_{18}O_2$ *d-β*-Hexyl benzoate				$C_{15}H_{22}O_2$ *d-β*-Octyl benzoate				$C_{18}H_{28}O_2$ *d-β*-Undecyl benzoate			
20	+39.23	+41.06	+46.59	+78.13	+35.38	+36.99	+42.20	+72.23	+33.27	+34.70	+39.65	+68.26	+27.55	+28.89	+32.92	+56.99
40	37.62	39.39	44.64	75.24	34.93	36.55	41.69	71.52	33.11	34.45	39.41	68.17	27.45	28.75	32.77	56.94
60	36.26	37.78	42.83	72.34	34.52	36.09	41.15	70.82	32.87	34.32	39.15	67.90	27.33	28.61	32.61	56.90
80	34.86	36.24	41.15	69.37	34.09	35.60	40.58	70.13	32.68	34.15	38.87	67.66	27.18	28.42	32.41	56.79
100	33.52	34.86	39.45	66.70	33.62	35.07	40.01	69.36	32.47	33.97	38.63	67.39	27.10	28.30	32.28	56.72
120	32.22	33.55	38.05	64.29	33.17	34.61	39.56	68.66	32.23	33.79	38.48	67.08	26.94	28.12	32.11	56.40
140	31.20	32.41	36.93	62.40	32.73	34.32	39.10	67.94	32.00	33.60	38.29	66.79	26.72	27.90	32.03	55.01
160	30.25	31.43	35.88	61.16	32.21	33.87	38.58	67.19	31.78	33.39	38.14	66.48	26.49	27.79	31.66	55.64
180	29.61	30.67	34.88	--------	31.75	33.40	38.14	66.31	31.44	33.20	37.96	66.18	26.25	27.46	31.37	55.14
	$C_{16}H_{24}O_2$ *d-γ*-Nonyl benzoate				$C_{16}H_{16}O_2$ *d*-Benzylmethylcarbinyl benzoate				$C_{15}H_{16}O_2$ *d-β*-Butyl *α*-naphthoate				$C_{17}H_{20}O_2$ *d-β*-Hexyl *α*-naphthoate			
0	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	+3.96	+3.53	+2.97	+2.95
10	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	4.84	4.85	5.13	5.49
20	+6.84	+7.27	+8.39	+15.95	+65.07	+68.14	+78.84	+144.54	+28.40	+29.82	+34.00	+60.03	5.87	6.08	6.55	8.00
40	7.88	8.21	9.59	17.92	62.73	65.68	75.77	139.75	27.44	28.76	32.80	57.98	7.48	7.82	8.55	12.53
60	8.70	9.16	10.57	19.55	60.46	63.45	73.24	134.82	26.42	27.68	31.59	55.85	9.02	9.40	10.48	16.90
80	9.38	9.86	11.39	21.07	58.32	61.38	70.72	129.06	25.38	26.69	30.47	53.97	10.32	10.85	12.37	20.86
100	10.00	10.52	12.02	22.34	56.41	59.36	68.24	125.10	24.48	25.72	29.42	52.29	11.54	12.14	13.82	23.95
120	10.59	11.18	12.88	23.68	54.64	57.41	66.20	121.70	23.65	24.95	28.40	50.85	12.53	13.23	15.10	26.40
140	11.10	11.84	13.48	24.75	53.23	55.77	64.46	118.72	22.97	24.16	27.48	49.56	13.37	14.10	16.03	28.53
160	11.60	12.24	13.92	25.60	52.08	54.47	62.91	116.25	22.42	23.46	26.68	48.44	14.14	14.88	16.98	30.53
180	12.03	12.74	14.50	26.37	51.00	53.29	61.45	115.25	21.90	22.98	26.01	47.35	14.84	15.22	17.81	32.32

Specific rotation $[\alpha]_\lambda^t$ *of esters of benzoic and naphthoic acids with secondary alcohols* (105)—Continued

	$C_{18}H_{22}O_2$ *d-β*-Heptyl *α*-naphthoate				$C_{19}H_{24}O_2$ *d-β*-Octyl *α*-naphthoate				$C_{21}H_{28}O_2$ *d-β*-Decyl *α*-naphthoate				$C_{22}H_{30}O_2$ *d-β*-Undecyl *α*-naphthoate			
0	+1.40	+1.29	+1.04	−2.30	−1.90	−2.11	−2.77	−9.36	−1.57	−1.67	−2.36	−9.14	--------	--------	--------	--------
10	2.78	2.78	2.65	+1.30	+.05	−.15	−.49	−4.48	−.01	−.01	−.40	−3.66	+0.19	+0.19	−0.20	−3.37
20	3.99	4.19	4.45	4.86	+1.67	+1.67	+1.47	−.39	+1.41	+1.38	+1.30	−.02	+1.63	+1.63	+1.55	+.45
40	6.27	6.63	7.44	10.71	4.18	4.18	4.48	+5.88	3.84	3.96	4.29	+5.86	3.78	3.89	4.23	6.14
60	8.39	8.71	9.88	15.52	6.22	6.23	6.97	11.34	5.78	5.95	6.63	10.81	5.63	5.79	6.44	10.47
80	9.96	10.28	11.88	19.63	8.01	8.14	9.23	15.75	7.49	7.73	8.70	15.03	7.32	7.52	8.45	14.36
100	11.25	11.61	13.53	23.13	9.56	9.97	11.28	19.68	9.04	9.40	10.61	18.91	8.87	9.16	10.33	18.15
120	12.57	13.00	14.97	26.64	10.93	11.49	13.06	23.26	10.48	10.94	12.33	22.30	10.14	10.55	11.88	21.42
140	13.67	14.19	16.18	29.43	12.17	12.74	14.46	26.16	11.71	12.23	13.88	25.48	11.16	11.71	13.27	24.19
160	14.42	15.05	17.12	31.69	13.19	13.77	15.72	28.97	12.75	13.30	15.15	28.55	12.10	12.74	14.45	26.62
180	15.11	15.84	17.97	33.82	14.20	14.76	16.90	31.25	13.40	14.22	16.22	31.53	12.90	13.93	15.61	28.77

	$C_{20}H_{26}O_2$ *d-γ*-Nonyl *α*-naphthoate				$C_{20}H_{18}O_2$ *d*-Benzylmethylcarbinyl *α*-naphthoate				$C_{15}H_{16}O_2$ *d-β*-Butyl *β*-naphthoate				$C_{17}H_{20}O_2$ *d-β*-Hexyl *β*-naphthoate			
20	−22.23	−23.34	−27.29	−51.39	+29.10	+30.74	+35.56	+68.67	+50.04	+52.62	+60.32	+109.82	+57.11	+60.00	+69.16	+127.44
40	−18.62	−19.63	−22.64	−41.94	29.63	31.35	36.14	70.24	46.82	47.88	56.44	101.62	55.30	58.22	66.97	123.81
60	−15.39	−16.36	−18.86	−34.80	30.10	31.84	36.69	71.46	43.75	45.80	52.74	94.33	53.60	56.38	64.69	119.84
80	−12.45	−13.26	−15.27	−28.18	30.55	32.28	37.18	72.51	40.78	42.87	49.20	88.61	51.82	54.48	62.36	115.71
100	−9.86	−10.47	−12.22	−21.88	30.91	32.61	37.62	73.38	38.57	40.47	46.59	84.45	50.19	52.57	60.28	111.25
120	−7.65	−8.02	−9.50	−16.25	31.31	32.86	38.01	74.10	36.87	38.78	44.47	80.74	48.75	50.82	58.36	106.98
140	−5.74	−5.98	−7.05	−12.13	31.58	33.09	38.28	74.67	35.13	37.00	42.32	76.67	47.54	49.53	56.92	103.90
160	−3.98	−4.18	−5.12	−8.47	31.80	33.33	38.53	75.14	33.68	35.37	40.51	75.36	46.03	48.57	55.95	102.64
180	−2.58	−2.78	−3.51	−5.51	32.05	33.58	38.77	75.60	32.62	34.13	39.12	--------	45.62	47.81	55.16	102.00

	$C_{19}H_{24}O_2$ *d-β*-Octyl *β*-naphthoate				$C_{22}H_{30}O_2$ *d-β*-Undecyl *β*-naphthoate				$C_{20}H_{26}O_2$ *d-γ*-Nonyl *β*-naphthoate				$C_{20}H_{18}O_2$ *d*-Benzylmethylcarbinyl *β*-naphthoate			
20	+56.25	+58.99	+68.11	+125.84	+50.03	+52.66	+60.72	+112.36	+19.14	+20.04	+23.30	+44.54	+122.83	+129.04	+149.82	+290.2
40	55.17	57.82	66.80	123.25	49.54	52.10	60.08	110.99	20.33	21.48	24.91	46.93	117.71	123.54	143.32	278.2
60	54.30	56.87	65.66	120.86	49.03	51.50	59.37	109.62	21.68	22.79	26.46	50.22	112.98	118.90	137.94	267.5
80	53.51	55.99	64.60	118.85	48.45	50.86	58.63	108.24	22.84	23.92	27.68	52.91	109.38	114.90	133.66	259.1
100	52.77	55.20	63.49	116.91	47.89	50.24	57.87	106.77	23.68	24.83	28.65	54.62	105.81	111.62	129.42	251.2
120	51.97	54.46	62.48	115.06	47.29	49.55	57.09	105.31	24.37	25.61	29.53	55.99	102.82	108.13	125.51	243.1
140	51.33	53.68	61.78	113.77	46.84	49.13	56.46	104.48	25.00	26.39	30.33	57.21	99.94	105.23	122.28	235.7
160	50.71	52.92	61.03	112.81	46.47	48.71	55.94	104.44	25.06	26.86	30.89	58.20	97.51	102.49	119.40	229.7
180	49.37	51.41	59.42	109.00	46.00	48.18	55.42	--------	25.92	27.32	31.49	59.21	95.41	100.56	116.44	225.0

Specific rotation of the above esters in approximately 5 per cent solution at laboratory temperature (**105**)

	d-β-Butyl benzoate				*d*-Benzylmethylcarbinyl benzoate				*d*-Benzylmethylcarbinyl β-naphthoate				*d*-γ-Nonyl benzoate			
s ↓ γ →	5,893	5,700	5,461	4,358	5,893	5,700	5,461	4,358	5,893	5,700	5,461	4,358	5,893	5,700	5,461	4,358
EtOH	+40.23	42.18	+48.04	+80.54	+70.49	+74.89	+86.86	+156.8	+127.9	+133.6	+155.4	+298.2	+12.01	+13.21	+14.85	+26.63
CS₂	40.38	42.13	48.11	81.94	69.49	73.08	85.09	158.0	131.3	138.1	160.3	315.4	1.25	1.63	1.83	3.46
	d-β-Hexyl benzoate				*d*-Benzylmethylcarbinyl α-naphthoate				*d*-γ-Nonyl β-naphthoate				*d*-γ-Nonyl α-naphthoate			
EtOH	+40.98	+42.91	+49.11	+84.33	+36.02	+37.59	+42.70	+79.39	+26.71	+28.49	+32.59	+63.23	−2.69	−3.07	−3.07	−7.29
CS₂	31.93	33.28	38.14	64.39	44.71	46.71	54.34	107.70	22.76	23.92	28.09	54.76	−15.00	−15.34	−18.07	−31.00
	d-β-Octyl benzoate				*d*-β-Octyl α-naphthoate				*d*-β-Octyl α-naphthoate							
Py	+25.43	+26.86	+31.23	+52.40	+8.72	+9.35	+10.61	+20.50	50.03	52.76	60.87	112.57				
C₆H₆	28.21	29.74	34.22	58.40	7.92	7.97	9.40	18.80	53.08	56.26	64.63	119.40				
CS₂	29.68	31.31	35.44	61.34	10.90	11.50	12.70	25.49	55.89	58.88	67.93	127.94				
CHCl₃	34.74	36.40	41.27	70.78	16.28	17.17	19.52	34.72	48.93	50.80	58.61	107.04				
EtOH	39.26	41.09	47.35	82.54	18.90	20.27	22.70	40.47	45.58	48.00	55.35	101.24				
AcOEt	42.51	44.31	51.31	88.22	19.61	20.89	23.42	40.85	58.95	62.03	71.44	130.05				

3. AMINO ACIDS

$C_{10}H_{11}NO_3$ N-Benzoylalanine[1]			$[a]_{\lambda}^{20}$ (170)		
	s	c	5,893	5,780	5,461
d-Acid	H_2O	1.022	2.4	2.7	3.2
l-Acid	H_2O	1.025	−2.4	−2.7	−3.2
d-Acid	EtOH	1.009	10.5	10.9	12.7
	Me_2O	1.016	24.9	26.1	30.2

$C_4H_8N_2O_3$ *l*-Asparagine (47; *cf.* 18, 210) s=H_2O $[a]_{\lambda}^{t}$				
t	p	5,893	5,461	4,358
34	1.961	−6.7	−7.5	−14.7
40	1.961	−7.7	−8.3	−17.7
60	1.961	−10.5	−11.3	−22.4
38	7.407	−6.4	−6.9	−13.2
52	7.407	−8.3	−9.3	−18.3
68	7.407	−10.5	−11.7	−23.5

$C_4H_7NO_4$ *l*-Aspartic acid. (47; *cf.* 18, 50, 140, 141) s=H_2O $[a]_{\lambda}^{t}$				
t	p	5,893	5,461	4,358
14	0.990	5.1	7.1	15.2
35	0.990	2.5	5.1	12.7
48	0.990	1.3	3.1	9.2
48	1.961	2.3	4.0	9.3
68	1.961	0.0	1.3	4.5
78	1.961	−1.5	−0.3	2.3

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[1] The effect of KOH on the specific rotation is also given in the article.

Specific rotation $\left[\alpha\right]_{\lambda}^{20}$ *of aminoglutaric acid and some derivatives* (**98**)

Formula	Substance	s	c \ γ	6, 563	6, 260	5, 893	5, 600	5, 463	5, 270	5, 165	4, 990	4, 861	4, 780
$C_5H_9NO_4$	*d*-α-Aminoglutaric acid+3 mols NaOH	(Cf. 4) dil. NaOH	[1] *6.42*	8.05	9.17	10.52	11.76	12.96	14.10	14.86	16.23	17.53	------
$C_7H_{11}NO_3$	Ethyl pyroglutamate	H_2O	*11.4*	−3.40	−3.21	−2.68	−2.04	−1.59	− .89	− .22	.86	1.99	------
$C_5H_7ClO_4$	*l*-α-Chloroglutaric acid	AcOEt	*5.08*	18.26	20.06	22.67	25.26	26.81	28.76	30.18	32.67	34.67	------
	l-α-Chloroglutaric acid (from zinc hydroxyglutarate).	------	*16.5*	22.75	24.78	27.14	29.63	30.48	32.71	34.28	------	------	------
$C_5H_8O_5$	*d*-α-Hydroxyglutaric acid	H_2O+HCl	*15.8*	−2.00	−1.64	−1.34	−.97	−.67	−.31	.00	.31	.67	------
$AgC_5H_5O_4$	Silver *d*-butyrolactone-γ-carboxylate	H_2O	*1.08*	5.67	7.31	8.59	9.78	9.14	11.52	10.88	9.23	13.16	12.07
$C_5H_6O_4$	*d*-Butyrolactone-γ-carboxylic acid (from zinc hydroxyglutarate).	do	*1.39*	1.11	1.80	2.14	2.42	2.83	3.25	3.39	3.53	3.66	------
	(From silver butyrolactonecarboxylate)	do	*.59*	−.33	1.50	2.67	3.00	3.33	3.67	3.84	4.00	4.17	4.34
$Zn(C_5H_7O_5)_2$	Zinc α-hydroxyglutarate	do	*.52*	4.24	5.69	6.65	7.71	8.24	8.82	9.39	------	------	------
$C_4H_7NO_4$	*d*-Aspartic acid+3 mols NaOH	dil. NaOH	*.366*	−3.54	−2.76	−2.48	−2.28	−2.13	−1.91	−1.61	−1.18	------	------
$C_8H_{15}NO_4$	Diethyl *d*-aspartate	EtOH	*4.58*	.98	1.25	1.73	2.08	2.25	2.53	2.78	2.98	3.38	------
$C_4H_5ClO_4$	*l*-Chlorosuccinic acid	H_2O	*5.15*	−15.04	−16.79	−18.92	−21.36	−22.96	−24.98	−26.17	−28.48	−30.90	------

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[1] Values in italics are expressed in per cent.

Amino-acids and derivatives (222) $[\alpha]^{20}_{\lambda}$

Formula	Substance	s	t	p	6,563	6,260	5,893	5,675	5,463	5,270
$C_9H_9N_3O_7$	*l*-3, 5-Dinitrotyrosine	HCl·H_2O	15	1.45	7.81	9.40	11.45	13.17	14.30	16.48
		N KOH	15	.773	2.58	.56	1.54	[1] 7.22	[2] 15.47	
$C_9H_{10}N_2O_5$	*l*-3-Nitrotyrosine	HCl·H_2O	15	1.93	1.31	2.36	3.21	3.82	3.97	
$C_9H_{11}NO_3$	*l*-Tyrosine	do	15	3.773	−10.27	−11.30	−12.30	−13.14	−13.76	−14.61
$C_9H_{11}NO_4$	*l*-3, 4-Dihydroxyphenylalanine	do	15	3.81	−11.44	−11.80	−12.74	−13.53	−15.02	
$C_9H_{12}N_2O_3$	*l*-3-Aminotyrosine	do	15	3.9	−3.69	−3.69	−3.61	−3.56	−3.54	
$C_9H_{13}N_3O_3$	*l*-3, 4-Diaminotyrosine	H_2O	20	3.36	.00	1.02	2.17	1.66	1.18	
$C_9H_{17}NO_3$	*l*-Hexahydrotyrosine	HCl·H_2O	20	[3] 4.13	10.16	11.83	13.18	14.37	15.70	17.16
$C_9H_9ClN_2O_3$	*l*-Tyrosine-3-diazonium chloride	do	20	2.52	7.81	9.50	11.87		(7.02 at λ=6,615)	

[1] 7.22 at λ=5,750.

[2] 15.47 at λ=5,600.

[3] 4.13 g in 100 cc.

$C_6H_{13}NO_2$, Leucine (232)						$C_5H_9NO_4$, Glutamic acid						$C_4H_7NO_4$, Aspartic acid			
HCl		NaOH				HCl		$CH_2Cl.CO_2H$		NaOH		HCl		NaOH	
r^1	$[\alpha]_D$	r^1	$[\alpha]_D$	r^1	$[\alpha]_D$	r^1	$[\alpha]_D$	r^1	$[\alpha]_D$	r^1	$[\alpha]_D$	r^1	$[\alpha]_D$	r^1	$[\alpha]_D$
0	−9.84	0	−9.84	2.30	4.60	0	12.62	0.28	16.64	0	12.62	0	5.87	0	5.87
.55	1.70	.54	−.58	2.54	6.74	.54	23.04	.55	18.68	.49	3.00	.29	9.00	.42	−3.54
.87	6.50	.59	.88	2.58	4.90	.82	26.88	1.24	18.73	.74	−.40	.39	11.8	.86	−14.7
1.06	7.83	.83	3.09	3.75	4.93	.84	28.84	1.47	19.80	.99	−4.73	.50	14.1	1.08	−14.5
1.34	11.20	.86	4.42			1.01	27.91	4.41	24.30	1.09	−3.97	.94	18.4	1.53	−9.9
2.21	12.56	.99	4.00			1.55	30.94			1.32	−.40	1.28	19.0	2.17	−5.1
2.82	11.23	1.30	7.51			2.26	31.10	s=CH_3CO_2H		1.60	4.50	1.44	21.6	2.80	−3.77
5.11	12.14	1.63	4.28			4.53	32.36			2.47	10.22	1.96	22.8	4.96	−3.47
7.51	11.39	1.75	5.39					1.47	13.90	5.96	10.90	3.04	23.6	6.21	−3.47
8.62	12.88	1.97	4.37					3.92	13.86			4.90	23.9		

[1] Ratio of the number of moles of the acid or base to the number of moles of the amino acid.

Molecular rotation $[M]^t_\lambda$

Substance (25, 14, 15, 16)	s	c	t° λ=	6,770	6,570	6,380	6,210	6,050	5,890	5,740	5,510	5,300	5,130	4,980	4,850
$C_4H_8O_5S$ *l-n-α*-Sulphobutyric acid	H_2O	[1] 8.15	(2)				−7.2		−7.8			−9.3			
Copper *d-n-α*-sulphobutyrate	H_2O	1.75	(2)	−24.8	−29.7	−29.7		−32.2	−34.0	−35.4	−38.2	−41.0			
Copper *l-n-α*-sulphobutyrate	H_2O	1.3	(2)	(−15 at 4,730)		+6.5	0	0	0		−6.5	−9	−11	−11	−13
Nickel *l-n-α*-sulphobutyrate	H_2O	2.27	(2)	+20.7	+20.7	+20.7	+25.3	+27.0	+28.2	+29.3	+31.6	+33.3	+35.6	+37.9	+40.2
Cobalt *l-n-α*-sulphobutyrate	H_2O	1.16	(2)			+25.8		+29.2	+31.4	+32.6	+34.8	+35.9	+40.4	+44.9	(3)
	EtOH	.79	(2)	+8		+8		+6.5			±0 (positive at 4,790)				
$C_{10}H_{13}NO_4S$ Anilido-*l-α*-sulphobutyric acid	H_2O	[4] 2.54	(2)				−9.7		−11.0	Neg.		−13.6			
Nickel anilido-*l-α*-sulphobutyrate	H_2O	1.6	(2)	(−77 at 4,730)		−25.5	−26.5	−29	−30	−34	−39.5	−49	−60		
	EtOH	1.45	(2)		−119.5	−121.5	−122.5	−122.5	−123.5	−123.5	−126.5	−132	−138	−144	
Copper anilido-*l-α*-sulphobutyrate	H_2O	.80	(2)	−20.5		−24.5		−32.5		−34.5	−41	−48	−55	−55	−58
	EtOH	.7	(2)			−23.5		−27.5	−31.5	−35	−41	−48			
Cobalt anilido-*l-α*-sulphobutyrate	H_2O	1.09	(2)	−16.5		−22									
	EtOH	.87	(2)	−53	−53	−53	−58	−27.5	−31.5	−38.5	−52	−64.5	−82.5	−85	−96
								−63	−78	−99	−109	−34	+27		−41
		λ=	5,220	5,130	5,050	4,910	4,790	4,730							
		[α]	0	+27	0	−34	−68	−82							
Barium anilido-*l-α*-sulphobutyrate	H_2O	3.65					−29		−34			−51			
$C_{10}H_{12}N_2O_3S$ *d*-Benzimidazole-2-propylsulphonic acid.															
Barium *d*-Benzimidazole-2-propylsulphonate	H_2O	2.6					+31		+34			+39			
Cobalt *d*-Benzimidazole-2-propylsulphonate	H_2O	1.88		+20		+22.5	+23.2	+24	+25	+26	+26.5	+30	+30		

[1] 0.485 *N*.

[2] Temperature not stated, but presumably that of the laboratory.

[3] +50 (λ=4,620).

[4] 0.09734 *M*.

IB$_2$. THE MOLECULE CONTAINS 2 ASYMMETRIC CARBON ATOMS WHICH ARE ATTACHED EACH TO 2 OTHER CARBON ATOMS

4. TARTARIC ACID AND ITS ESTERS

Specific rotation $\left[\alpha\right]^{20}_{\lambda}$ *of d-tartaric acid in aqueous solution*[1] **(121)**

d	1.2987	1.2658	1.2352	1.2052	1.1760	1.1476	1.1201	1.0942	1.0692	1.0448	1.0211
λ ↓ p→	55.0	50.0	45.0	40.0	35.0	30.0	25.0	20.0	15.0	10.0	5.0
6,438	6.004	6.734	7.421	8.078	8.728	9.336	9.886	10.457	11.047	11.645	12.209
5,893	6.501	7.366	8.219	9.010	9.799	10.500	11.207	11.949	12.642	13.304	14.070
5,790	6.566	7.466	8.331	9.162	9.975	10.752	11.481	12.197	12.948	13.687	14.527
5,769	6.577	7.487	8.346	9.184	10.014	10.786	11.535	12.246	12.980	13.687	14.527
5,461	6.613	7.653	8.645	9.594	10.532	11.417	12.237	13.061	13.925	14.740	15.669
5,086	6.235	7.479	8.668	9.784	10.876	11.927	12.904	13.899	14.855	15.856	17.040
4,800	5.348	6.781	8.150	9.430	10.714	11.859	13.032	14.162	15.297	16.446	17.922
4,678	4.739	6.241	7.707	9.056	10.427	11.660	12.969	14.051	15.359	16.558	18.150
4,358	1.848	3.631	5.421	7.025	8.637	10.131	11.570	13.023	14.486	15.952	17.791

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[1] In fused and supercooled states: (28). In various solvents: (**10, 11**, 83, **90, 93, 117, 184, 211, 213, 229, 230**).

Rotatory dispersion in aqueous solutions of d-tartaric acid at **20°**; *constants and anomalies* **(121)**

(Range λ=6,438-4,358) $[M]=\frac{k_1}{10^{-8}(\lambda^2-\lambda_1^2)}-\frac{k_2}{10^{-8}(\lambda^2-\lambda_2^2)}$. $(10^{-8}\lambda_1^2=0.03)$ $(10^{-8}\lambda_2^2=0.074)$

p	k_1	k_2	$10^{-4}\lambda$[1] (*Inflection*)	$10^{-4}\lambda$ (*Maximum*)	$10^{-4}\lambda$[1] (*Reversal*)
55.0	17.127	12.093	*0.6571*	0.5527	*0.4239*
54.1	17.188	12.080	.6533	.5485	.4220
50.0	17.485	12.043	.6376	.5373	*.4140*
45.0	17.686	11.877	.6197	.5232	*.4050*
41.25	17.960	11.869	.6092	.5150	.3997
40.0	18.053	11.865	.6058	.5123	*.3980*
35.0	18.367	11.812	.5929	.5022	*.3915*
30.0	18.709	11.799	.5822	.4937	*.3861*
25.0	18.936	11.714	.5722	.4859	*.3812*
20.0	19.160	11.624	.5628	.4785	*.3767*
15.0	19.485	11.605	.5543	.4720	*.3726*
10.0	19.657	11.475	.5458	.4653	*.3684*
5.0	19.592	11.108	.5341	.4562	*.3628*

---

[1] All values which lie outside the range of observations are in italics.

$C_6H_{12}O_6$ specific rotation $\left[a\right]^{20}_\lambda$ of dimethyl d-tartrate (**120**; cf., **6**, **51**, **167**, **228**)

$$\left[a\right]^t_\lambda = \frac{K_1}{10^{-8}(\lambda^2-\lambda_1^2)} - \frac{K_2}{10^{-8}(\lambda^2-\lambda_2^2)}. \quad (10^{-8}\lambda_1^2=0.030)$$

s	c	k_1	k_2	$10^{-8}\lambda_2^2$	Range λ	λ=6,708	6,438
Nil	--------	22. 576	20. 079	0. 056	6, 708–3, 741	+2. 79	+2. 65
Nil at 100.5° C	--------	24. 762	21. 193	. 052	6, 708–4, 135	+5. 69	+5. 80
H_2O	25	17. 145	9. 979	. 065	6, 438–4, 358	----------	+16. 04
$CHONH_2$	25	17. 049	10. 640	. 070	6, 708–4, 137	+12. 65	+13. 41
$C_2H_4Cl_2$	25	20. 360	22. 202	. 058	6, 708–4, 236	−8. 16	−9. 31
$(CH_3)_2CO$	25	27. 425	24. 000	. 054	6, 708–3, 750	+4. 59	+4. 67
C_5H_5N Pyridine	20	19. 448	6. 683	. 082	6, 438–4, 800	----------	+30. 48
C_7H_8O Anisole	20	42. 828	43. 581	. 047	6, 438–4, 358	----------	−7. 20
C_9H_7N Quinoline	21. 5	37. 555	33. 211	. 058	6, 438–4, 800	----------	+4. 47

s	λ=5,893	5,780	5,461	5,086	4,800	4,678	4,358
Nil	+2. 22	+2. 05	+1. 28	−0. 39	−2. 47	----------	−8. 93
Nil at 100.5° C	+6. 27	+6. 29	+6. 25	+5. 68	+4. 74	+4. 07	+1. 26
H_2O	----------	+19. 28	+21. 17	+23. 44	+25. 23	+25. 86	+27. 33
$CHONH_2$	+15. 39	+15. 80	+16. 96	+18. 14	+18. 74	+18. 87	+17. 85
$C_2H_4Cl_2$	----------	−13. 50	−16. 51	−21. 53	−27. 09	−30. 12	−40. 92
$(CH_3)_2CO$	+4. 62	+4. 50	+4. 01	+2. 73	+0. 87	----------	----------
C_5H_5N Pyridine	+36. 32	+37. 44	+41. 60	+47. 15	+52. 01	----------	----------
C_7H_8O Anisole	----------	−11. 00	−13. 80	----------	−23. 68	----------	−37. 08
C_9H_7N Quinoline	+3. 56	+3. 19	+1. 73	−1. 35	−5. 24	----------	----------

$C_8H_{14}O_6$ Diethyl *d*-tartrate $\left[\alpha\right]^t_\lambda$ (**146**)

λ	6, 708	6, 234	5, 769	5, 461	4, 960	4, 358
t	s=C_5H_5N Pyridine. *p*=19.263					
0. 0	34. 74	39. 50	46. 75	52. 06	62. 48	78. 63
15. 7	32. 26	36. 63	43. 23	48. 11	57. 63	72. 06
58. 6	26. 38	29. 90	35. 03	38. 70	45. 89	59. 90
100. 0	21. 99	25. 19	29. 50	32. 63	38. 41	46. 51
	s=C_7H_6O Benzaldehyde. *p*=10.365					
17. 0	----------	39. 12	42. 35	47. 33	57. 26	[1] 73. 3
86. 7	----------	26. 49	[1] 30. 5	33. 93	[1] 39. 8	[1] 49. 4
135. 5	----------	22. 66	26. 52	29. 18	34. 07	41. 93
λ	6, 708	6, 234	5, 790	5, 461	4, 960	4, 358
t	s=$C_7H_6O_2$ Salicylaldehyde. *p*=20.214					
19. 8	20. 34	23. 88	27. 36	30. 39	35. 73	43. 52
32. 1	[1] 20. 0	[1] 23. 54	[1] 27. 0	[1] 30. 0	[1] 35. 3	[1] 42. 6
61. 1	19. 81	22. 97	[1] 26. 2	[1] 29. 1	34. 43	40. 93
79. 5	19. 13	22. 36	25. 55	28. 32	33. 29	39. 34
114. 2	18. 23	21. 23	24. 21	26. 74	31. 57	37. 09
	s=C_9H_7N Quinoline. *p*=4.972					
19. 8	38. 25	30. 3	35. 07	38. 25	44. 00	49. 46
60. 3	[1] 20. 0	[1] 22. 4	25. 94	27. 73	31. 2	[1] 32. 3
82. 0	18. 13	20. 57	23. 50	25. 15	27. 75	31. 26
99. 0	17. 47	19. 5	22. 35	24. 08	27. 27	29. 20
	s=C_9H_7N Quinoline. *p*=13.601					
−13. 0	[1] 34. 4	[1] 39. 0	[1] 46. 0	50. 93	60. 86	[1] 73. 3
0. 0	31. 13	35. 23	41. 20	45. 42	53. 77	63. 63
16. 8	----------	30. 29	35. 26	38. 70	45. 18	52. 06
44. 5	31. 60	24. 54	28. 00	30. 60	35. 17	38. 78
65.	19. 19	21. 55	24. 48	26. 76	30. 41	32. 58
116. 0	18. 21	20. 36	22. 92	25. 14	----------	--------

[1] These values have been interpolated by the compiler from the author's data.

$C_8H_{14}O_6$, Diethyl *d*-tartrate [1] **(152)**

s = $C_2H_4Br_2$ + $PhNO_2$					
p	*p* of $PhNO_2$	$[a]_D^{20}$	*p*	*p* of $PhNO_2$	$[a]_D^{20}$
19.925	100.00	25.9	19.926	33.35	6.06
17.105	61.92	15.95	13.391	15.55	−1.70
19.922	49.95	11.50	19.942	.00	−7.56
15.022	35.63	7.01	12.061	.00	−10.72
14.928	35.03	6.80			

[1] In other solvents see **(149, 150, 152)**.

$C_8H_{14}O_6$, Diethyl tartrate **(123, 124)**

$$a=\frac{k_1}{10^{-8}(\lambda^2-\lambda_1^2)}-\frac{k_2}{10^{-8}(\lambda^2-\lambda_2^2)}. \quad (10^{-8}\lambda_1^2=0.030)$$

t	k_1	k_2	$10^{-8}\lambda_2^2$	Range λ
[1] 20.0	25.005	20.678	0.056	6,708–3,860
20.0	25.22	21.05	.055	6,708–3,879
64.3	22.941	17.670	.057	6,708–3,923
98.7	24.091	18.284	.055	6,708–4,358
s	(*c*=25)			
$CHONH_2$	19.62	9.46	.07	6,708–3,960
$C_2H_4Br_2$	18.08	19.335	.061	6,708–4,154

[1] The ester used for these determinations was specially purified by distillation and freezing and had a setting point of 18.7° C.

Specific rotatory power $[a]_\lambda^{20}$ *of diethyl tartrate* **(123, 124)**

s	*c* \ λ	6,708	5,893	5,780	5,461	4,358
Nil at 20°	------	6.87	7.82	7.88	7.87	[1] 1.98
		6.69	7.45	7.52	7.50	1.62
Nil at 64.3°	------	9.64	11.44	11.66	12.28	10.42
Nil at 98.7°	------	11.09	13.35	13.70	14.64	15.13
H_2O [2]	20	18.23	23.39	24.46	27.06	38.18
	25	18.59	23.74	24.60	27.19	37.89
CCl_4	20	.20	−1.34	−1.73	−3.11	−17.17
$CHBr_3$	20	1.84	.83	.63	−.30	----------
$CHONH_2$	5	22.80	29.38	30.50	33.73	46.75
	10	22.75	28.99	30.01	33.20	46.30
	20	21.87	27.80	28.76	31.86	43.89
	25	21.81	27.73	28.72	31.70	43.68
$C_2H_2Br_4$	23	−6.30	----------	−11.33	−13.95	−35.36
$C_2H_2Cl_4$	5	−10.35	−15.17	−16.20	−19.55	−45.17
	10	−9.54	−14.31	−15.26	−18.48	−43.57
	20	−8.13	−12.41	−13.30	−16.33	−39.70
$C_2H_4Br_2$	5	−10.90	−16.60	−17.11	−20.73	−48.70
	10	−9.60	−14.26	−15.23	−18.65	−44.76
	20	−7.40	−11.52	−12.35	−15.23	−38.76
	25	−6.66	−10.56	−11.33	−14.11	−36.77
$C_2H_4Cl_2$	5	−1.71	----------	−4.63	−6.40	−23.80
	10	−1.55	−3.76	−4.24	−6.09	−23.11
	20	−1.36	−3.63	−4.11	−5.88	−22.39
$C_3H_6Br_2$	20	−1.50	−3.40	−4.40	−6.40	−23.35
C_3H_5OH	40	9.38	11.09	11.30	11.88	10.00
Me_2CO	5	10.73	12.80	13.23	13.97	11.37
	10	10.10	12.28	12.63	13.24	10.99
	20	9.90	11.66	11.93	12.46	9.52
$C_6H_5NO_2$	20	19.32	24.45	26.02	29.01	----------

---

[1] The ester used for these determinations was specially purified by distillation and freezing and had a setting point of 18.7° C. Specific rotations for other wave lengths are as follows:

λ=	6,438	6,362	5,782	5,700	5,218	5,153	5,105	5,086	4,810	4,800
$[\alpha]_\lambda^{20}$=	7.38	7.43	7.87	7.88	7.61	7.48	7.36	7.34	6.25	6.22
λ=	4,722	4,678	4,603	4,475	4,415	4,359	4,315	4,271	4,240	4,210
$[\alpha]_\lambda^{20}$=	5.75	5.45	4.9	3.5	2.8	2.1	1.4	0.7	0	−0.7
λ=	4,148	4,119	4,071	4,005	3,967	3,900	3,889	3,872	3,868	3,860
$[\alpha]_\lambda^{20}$=	−2.1	−2.8	−4.2	−6.2	−7.7	−10.3	−11.1	−11.5	−11.8	−12.2

[2] The data for water are uncertain, on account of hydrolysis; but they serve to show the general character of the dispersion in this solvent.

$C_8H_{14}O_6$ *Diethyl tartrate* [1] $\left[\alpha\right]_D^t$ (231)

s=H_2O

t ↓ p→	100	75.05	50.23	25.03	10.08	5
20	7.67	11.81	17.51	23.69	25.98	26.52
30	8.72	12.38	17.34	23.13	25.52	26.28
40	9.72	12.90	17.18	22.55	25.00	25.78
50	10.60	13.37	17.04	21.97	24.41	25.17
60	11.31	13.65	16.90	21.40	23.76	24.52
70	11.94	13.90	16.77	20.81	23.08	23.89
80	12.50	14.14	16.65	20.23	22.39	23.25
90	13.01	14.40	16.53	19.65	---	---
100	13.47	14.65	16.42	19.06	---	---

s=MeOH

t ↓ p→	100	75	50	25	10	5
20	7.67	9.13	10.45	11.20	11.45	11.51
30	8.72	10.10	11.34	12.07	12.30	12.37
40	9.72	11.00	12.15	12.80	13.10	13.10
50	10.60	11.80	12.82	13.48	13.48	13.74

s=EtOH

t ↓ p→	100	60	50	25	10	5
20	7.67	7.60	7.90	8.37	8.55	8.75
30	8.72	8.70	9.00	9.52	9.60	9.75
40	9.72	9.63	10.02	10.46	10.62	10.75

s=$CHCl_3$

t ↓ p→	100	79.95	60.04	39.91	19.12	9.0
20	7.67	3.84	0.70	1.56	2.80	2.80
30	8.72	5.23	2.32	.32	.89	.89
40	9.72	6.46	3.83	2.05	.82	.79
50	10.60	7.67	5.26	3.61	2.50	2.30

---

[1] For dispersion (light-filter sources only) see (**228**, **229**); for influence of solvents, concentration, and temperature see (**6**, **74**, **151**, **167**).

$C_8H_{14}O_6$, *Diethyl tartrate* (**231**)

s=$CHONH_2$ Formamide			s=$C_2H_4Br_2$ Ethylene bromide		
p	d_4^{20}	$[\alpha]_D^{20}$	p	d_4^{20}	$[\alpha]_D^{20}$
74.67	1.1986	16.00	69.60	1.3867	2.62
51.10	1.1806	22.55	44.47	1.5899	−1.94
25.69	1.1577	27.60	22.49	1.8297	−6.99
8.86	1.1425	29.74	11.58	1.9814	−10.79
5.35	1.1396	30.13	5.53	2.0788	−14.16
1.90	1.1365	30.3	2.31	2.1362	−16.72
			1.20	2.1567	−17.3
			.42	2.1713	−18.7

$C_{12}H_{22}O_6$ *Diisobutyl tartrate* $[\alpha]_\lambda^t$ (**146**)

t ↓ λ→	6,716	6,234	5,790	5,461	4,960	4,358
73.0	15.86	17.94	20.50	22.77	26.14	29.69
99.0	16.33	18.51	21.17	23.34	27.19	31.40
132.0	16.42	18.73	21.43	23.64	27.75	32.33
171.7	16.02	18.31	20.94	23.14	27.34	32.10
193.0	15.64	17.93	20.56	22.71	26.86	31.73
226.3	15.28	17.30	19.79	21.97	26.03	30.96
s=$C_2H_2Cl_4$. p=33.362						
0.0	5.46	5.82	5.97	5.81	4.56	−0.26
16.4	7.47	8.23	8.89	9.15	8.84	5.63
44.0	10.19	11.39	12.58	13.43	14.32	13.31
68.0	11.90	13.34	14.91	16.01	17.84	18.24
99.4	13.26	14.92	16.84	18.35	20.78	22.56
s=$C_2H_3Cl_4$. p=48.15						
24.8	9.29	10.44	11.50	12.20	12.74	11.04
42.2	10.85	12.24	13.58	14.57	15.83	15.30
67.0	12.39	14.07	15.82	17.21	19.25	20.08
99.7	13.78	15.59	17.60	19.28	22.06	24.26
s=C_9H_7N Quinoline. p=20.066						
0.0	54.49	63.29	73.72	83.36	103.44	133.63
39.35	39.40	45.63	62.56	59.45	72.50	91.47
69.75	32.67	37.69	52.79	48.15	58.62	73.26
99.5	28.35	32.48	42.99	41.87	50.61	62.28
147.5	23.93	28.30	[1] 37.63	[1] 36.9	42.94	[1] 52.9

[1] These values have been interpolated by the compiler from the author's data.

$C_{16}H_{26}O_8$ Diisobutyl diacetyl-d-tartrate (**146**)

t ↓ λ→	6,742	6,234	5,790	5,461	4,960	4,358
−21.0	[1] 16.2	[1] 16.5	18.63	20.33	23.34	25.92
0.0	13.53	15.29	17.34	18.95	21.63	23.86
14.0	12.86	14.69	16.58	18.15	20.74	22.92
17.25	12.83	14.54	16.42	17.96	---	---
42.25	12.21	13.94	15.75	17.09	19.75	21.93
75.2	11.92	13.61	15.45	16.94	19.60	22.22
98.9	11.94	13.80	15.69	17.30	20.14	23.32
200.0	14.28	16.51	19.00	21.26	---	31.45
s = $C_2H_2Cl_4$. *p* = 20.034						
t ↓ λ→	6,716	6,234	5,790	5,461	4,960	4,358
0.0	10.62	11.75	13.06	14.25	15.87	16.51
16.9	9.86	11.10	[1] 12.5	[1] 13.5	14.93	[1] 15.4
43.0	9.49	10.57	11.87	12.82	14.29	14.65
57.5	[1] 9.4	10.49	[1] 11.6	12.68	14.26	[1] 14.8
76.85	9.35	10.40	11.70	12.73	14.41	15.49
99.75	9.63	10.80	12.12	13.24	15.27	16.78
s = $C_7H_7NO_2$ *o*-Nitrotoluene. *p* = 58.86						
0.0	3.38	2.96	2.11	0.91	−3.52	−18.30
46.7	5.18	5.31	5.22	4.81	2.52	−6.21
99.1	7.48	8.15	8.80	9.17	8.97	[2] 9.34
147.0	9.61	10.93	12.27	13.19	14.16	---
s = $C_7H_7NO_2$ *o*-Nitrotoluene. *p* = 24.694						
0.0	−3.08	−4.60	−7.20	−10.19	−19.41	[2] −42.85
17.0	[1] −1.4	[1] −2.8	−4.83	−7.36	[1] −14.9	[2] −33.22
49.8	1.65	0.71	−0.49	−1.94	−7.14	---
73.7	3.74	2.99	2.47	1.62	−1.93	---
150.0	7.68	8.31	8.83	9.00	9.11	---
s = C_9H_7N Quinoline. *p* = 74.96						
t ↓ λ→	6,742	6,234	5,790	5,461	4,960	4,358
0.0	15.51	17.81	20.32	22.44	26.22	30.54
16.6	14.64	16.73	19.17	21.09	24.55	28.65
59.75	13.23	15.15	17.26	19.06	22.22	25.70
100.0	12.89	14.77	---	18.75	22.02	---
s = C_9H_7N Quinoline. *p* = 20.476						
0.0	33.53	39.32	46.48	52.79	65.26	89.54
17.0	---	34.35	[1] 40.5	[1] 46.1	57.41	76.59
36.7	---	29.94	[1] 35.2	[1] 39.8	49.56	66.04
76.75	21.37	24.37	[1] 28.5	[1] 32.2	39.22	51.00
103.2	19.49	[1] 22.1	[1] 25.8	[1] 29.2	35.35	---

[1] These values have been interpolated by the compiler from the author's data.

[2] These readings were difficult to make and are, therefore, less accurate.

Rotatory dispersion of tartrates (**65**)

$[\alpha]_{\lambda}^{t}$ $l=2$ dm

t	λ / d_4^t	6,708	6,563	6,147	5,893	5,769	5,679	5,568	5,461	5,219	4,861	4,662
$C_{12}H_{22}O_6$, *n*-Dibutyl *d*-tartrate												
9.0	1.1044	7.44	7.68	8.32	8.67	8.82	8.92	9.04	9.13	9.26	8.7	8.1
21.5	1.0934	8.55	8.80	9.63	10.20	10.45	10.61	10.81	11.00	11.25	11.23	11.0
41.5	1.0759	9.93	10.22	11.27	11.92	12.27	12.50	--------	13.08	13.61	14.19	14.1
72.5	1.0492	11.31	11.73	13.06	13.91	14.36	14.65	15.05	15.44	16.26	17.4	17.9
98.0	1.0269	12.11	12.54	13.99	14.95	15.45	15.83	16.29	16.75	17.87	19.43	20.2
118.0	1.0099	12.39	12.83	14.36	15.35	15.89	16.30	16.82	17.26	18.39	20.21	20.9
128.0	1.0011	12.4	12.91	14.51	15.53	16.08	16.46	16.97	17.53	18.65	20.4	--------
140.0	.9906	12.44	13.00	14.54	15.65	16.23	16.62	17.15	17.63	18.88	20.76	21.4
151.0	.981	12.54	12.97	14.54	15.69	16.19	16.57	17.04	17.66	18.77	20.51	21.6
165.0	.969	12.52	12.99	14.58	15.69	16.25	16.67	17.16	17.67	18.97	20.60	21.9
$C_{18}H_{34}O_6$, *n*-Diheptyl *d*-tartrate												
44.5	0.9952	7.66	7.92	8.70	9.17	9.43	9.64	9.84	10.03	10.44	10.77	10.6
79.0	.9685	8.87	9.20	10.16	10.88	11.23	11.49	11.78	12.08	12.73	13.69	14.1
100.0	.9520	9.27	9.59	10.71	11.43	11.81	12.12	12.44	12.79	13.60	14.76	15.2
125.2	.9328	9.66	10.00	11.16	11.96	12.38	12.71	13.09	13.48	14.46	15.78	16.5
149.0	.914	9.78	10.17	11.35	12.14	12.60	12.88	13.33	13.71	14.77	16.18	16.9
168.0	.8995	9.68	10.06	11.30	12.12	12.59	12.88	13.29	13.69	14.68	16.20	16.8
$C_{20}H_{38}O_6$, *n*-Dioctyl *d*-tartrate												
45.0	0.9817	7.14	7.35	8.05	8.51	8.73	8.88	9.08	9.29	9.71	9.98	9.9
79.0	.9551	8.32	8.59	9.54	10.18	10.51	10.75	11.05	11.32	12.02	12.72	13.0
89.0	.9473	8.54	8.84	9.86	10.53	10.86	11.13	11.44	11.76	12.53	13.40	13.8
112.0	.9292	8.90	9.26	10.35	11.06	11.44	11.73	12.07	12.42	13.32	14.50	15.0
132.0	.9140	9.04	9.39	10.51	11.26	11.65	11.93	12.30	12.68	13.57	14.96	15.6
145.0	.9035	8.06	9.41	10.58	11.34	11.73	12.01	12.40	12.73	13.66	15.07	15.8
165.0	.887	9.05	9.41	10.54	11.33	11.74	12.06	12.45	12.80	13.74	15.04	16.0

d-Tartrates (128, 145; cf. 6, 167, 228, 229)

$C_{10}H_{14}O_6$ t	Diallyl $[\alpha]_D^t$
15.6	15.28
20.0	15.52
33.2	16.23
71.5	17.95
106.6	18.66
131.6	18.82
148.2	18.75
168.0	18.44

$C_{10}H_{18}O_6$	Di-*n*-propyl
16.5	12.22
20.0	12.54
45.5	14.52
77.7	16.48
111.2	17.44
123.0	17.62
133.2	17.72
147.2	17.82
161.0	17.77
173.0	17.70

$C_{10}H_{18}O_6$	Diisopropyl
15.3	20.55
20.0	20.90
49.7	22.66
73.0	23.67
118.0	24.69
136.0	24.82
144.5	24.79
155.0	24.77
173.0	24.63

$C_{12}H_{22}O_6$ t	Diisobutyl $[\alpha]_D^t$
20.0	17.75
69.1	19.83
80.6	20.03
97.5	20.44

$C_{14}H_{26}O_6$	Ethyl octyl
16.0	7.63
21.5	7.83
41.5	9.36
50.0	10.13
62.0	10.89
71.0	11.43
98.0	12.72

$C_{18}H_{30}O_8$	Ethyl octyl diacetyl
18.5	4.20
44.0	4.63
61.0	5.37
81.5	6.43
100.0	7.23

$C_{20}H_{33}O_6$ t	Di-*d*-β-octyl $[\alpha]_D^t$
16.4	10.25
20.0	10.45
41.0	11.38
74.4	12.54
107.5	13.31
133.0	13.58
159.0	13.75
173.0	13.67
179.0	13.64

$C_{28}H_{34}O_8$	Ethyl octyl dibenzoyl
10.8	49.41
24.2	49.31
38.0	49.16
47.5	48.81
54.0	48.64
67.0	48.39
79.0	47.12
88.0	46.18
99.0	44.88

$C_{20}H_{38}O_6$ Di-β-octyl tartrates $[\alpha]_D^{17}$ **(161)**

	d-Tartrate	*l*-Tartrate	*r*-Tartrate
Di-*d*-β-octyl	24.06	2.06	14.12
Di-*l*-β-octyl	−1.93	−24.20	−14.03
Di-*dl*-β-octyl	11.02	−11.00	0.00

d-Tartrates of organic bases in water [1]

Neutral salts (87) $c=$	2.5 $[\alpha]_D^{20}$	5.0 $[\alpha]_D^{20}$	5.0 $[M]_D^{20}$
$C_4H_6O_6$ *d*-Tartaric acid	14.44	14.02	21.0
$C_{12}H_{28}N_2O_6$ *n*-Butylamine	17.40	17.86	52.9
$C_{14}H_{16}N_2O_6$ Pyridine	18.72	19.30	59.5
$C_{14}H_{28}N_2O_6$ Piperidine	16.80	17.12	54.8
$C_{16}H_{20}N_2O_6$ Aniline	16.12	16.58	55.7
$C_{18}H_{24}N_2O_6$ Benzylamine	17.40	18.28	66.5
$C_{22}H_{20}N_2O_6$ Quinoline	12.80	13.22	54.0
$C_{22}H_{28}N_2O_6$ Tetrahydroquinoline	12.80	13.42	55.8
Acid salts (39)	c	$[\alpha]_D^{20}$	$[M]_D^{20}$
$C_4H_6O_6$ *d*-Tartaric acid	1.50	15.0	22.5
$C_4H_9NO_6$ Ammonia	1.67	25.55	42.7
$C_5H_{11}NO_6$ Methylamine	1.81	23.4	42.35
$C_8H_{17}NO_6$ Diethylamine	2.23	18.98	42.35
$C_9H_{11}NO_6$ Pyridine	2.29	18.5	42.35
$C_{10}H_{13}NO_6$ Aniline	2.43	17.42	42.35
$C_{10}H_{13}NO_7$ *p*-Aminophenol	2.59	16.2	42.0
$C_{11}H_{15}NO_6$ *o*-Toluidine	2.57	16.34	42.0
m-Toluidine	2.57	16.47	42.35
p-Toluidine	2.57	16.60	42.7
$C_{11}H_{15}NO_6$ Benzylamine	2.57	16.60	42.7
$C_{11}H_{15}NO_7$ *p*-Anisidine	2.73	15.4	42.0
$C_{12}H_{17}NO_7$ *p*-Phenetidine	2.87	14.75	42.4
$C_{13}H_{13}NO_6$ Quinoline	2.79	14.95	41.7
$C_{13}H_{19}NO_6$ Pseudocumidine	1.14	14.92	42.5
Neutral salts (30)			
$C_4H_{12}N_2O_6$ Ammonia	1.84	34.6	63.7
$C_6H_{16}N_2O_6$ Methylamine	2.12	29.7	63.1
$C_{12}H_{28}N_2O_6$ Diethylamine	2.96	21.1	62.6
$C_{14}H_{16}N_2O_6$ Pyridine	3.08	19.2	59.2
$C_{16}H_{20}N_2O_6$ Aniline	3.36	17.1	57.5
$C_{18}H_{24}N_2O_6$ *o*-Toluidine	3.64	15.6	56.7
m-Toluidine	3.64	15.8	57.6
p-Toluidine	3.64	15.85	57.7
$C_{18}H_{24}N_2O_6$ Benzylamine	3.64	17.4	63.4
$C_{22}H_{20}N_2O_6$ Quinoline	4.08	13.5	55.0

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[1] For effects of different ratios of acids to amines see (135).

d-Tartrates of organic bases in water—Continued

s	c, p, or d	(157, 180, 181) $[\alpha]_D^{20}$	$[M]_D^{20}$
$C_6H_{10}O_6$ Dimethyl *d*-tartrate			
Nil	1.3284	2.14	3.8
H_2O	[1] *5.0231*	20.04	35.7
$C_8H_{14}O_6$ Diethyl *d*-tartrate			
Nil	1.2059	7.62	15.7
n-BuOH (*1,594*)	*5.3231*	8.47	
	23.106	7.46	
	43.638	6.97	
	59.440	6.86	
	80.990	7.07	
iso-BuOH (*1,594*)	*4.510*	7.10	
	27.278	6.01	
	50.315	5.55	
	65.578	5.85	
	83.960	6.64	
C_6H_6	*5.6479*	6.75	+13.9
	10.7339	6.29	+13.0
	21.0627	6.12	+12.6
$C_{10}H_{18}O_6$ Dipropyl *d*-tartrate			
Nil	1.1344	12.31	28.81
H_2O	*4.8206*	26.67	62.4
C_6H_6	*5.6205*	19.62	45.9
	11.1266	20.34	47.6
	22.2112	18.31	42.8
Dimethoxysuccinates			
$C_8H_{14}O_6$ Dimethyl			
Nil [2]	1.1317	[2] 82.52	[2] 170.0
H_2O	19.9988	78.71	162.1
	10.0315	78.45	161.6
	5.0319	78.50	161.7
MeOH	*6.2598*	81.04	166.9
	12.0806	76.32	157.2
	23.0151	78.90	162.5
C_6H_6	20.0036	101.63	209.4
	10.0128	104.66	215.6
	5.0060	105.47	217.3
$C_{10}H_{18}O_6$ Diethyl			
Nil [2]	[2] 1.0556	[2] 85.39	[2] 199.8
	1.0961	89.96	210.6
H_2O	5.3752	89.11	208.5
MeOH	*6.0569*	87.66	205.1
	9.7365	87.41	204.5
	19.0407	87.27	204.2
C_6H_6	*5.3130*	104.93	245.5
	10.1117	104.14	243.7
	19.3137	102.65	240.2
$C_{12}H_{22}O_6$ Dipropyl			
Nil [2]	[2] 1.0237	[2] 81.06	[2] 212.5
	1.0612	84.92	222.4
MeOH	*6.6571*	84.99	222.7
	12.3697	84.50	221.4
	23.7085	85.79	224.8
C_6H_6	*5.6932*	101.26	265.3
	11.4730	101.00	264.6
	21.5619	99.24	260.0

[1] The *p* values are in italics.

[2] At $t = 60°$ C.

d-Tartrates of organic bases in water—Continued

t or p [1]	d^t_4 (64)	$[\alpha]^t_D$
$C_{20}H_{16}Cl_2O_8$, Dimethyl di-*o*-chlorobenzoyltartrate		
13.1	1.3793	−48.83
20.6	1.3719	−49.22
46.8	1.3467	−49.79
69.8	1.3246	−48.94
83.1	1.3117	−47.95
87.5	1.3075	−47.51
99.2	1.2962	−46.80
s=EtOH. *p*=1.606		
20	0.7964	−51.99
$C_{20}H_{16}Br_2O_8$, Dimethyl di-*o*-bromobenzoyltartrate		
27	1.602	−34.29
38	1.587	−34.74
60	1.559	−34.23
75	1.543	−33.79
93	1.524	−32.89
s=EtOH. *t*=20°		
1.486	0.8009	−37.39
.9996	.7951	−36.51
s=Py. *t*=20°		
1.408	0.9860	−33.12
1.121	.9831	−33.61
$C_{20}H_{16}Br_2O_8$, Dimethyl di-*m*-bromobenzoyltartrate		
4	1.620	−83.26
16	1.605	−82.05
23	1.595	−81.33
40	1.573	−79.19
75	1.531	−73.80
$C_{20}H_{16}Cl_2O_8$, Dimethyl di-*m*-chlorobenzoyltartrate		
16.2	1.3556	−92.09
26.0	1.3463	−91.00
35.4	1.3375	−89.67
42.4	1.3307	−88.61
52.6	1.3213	−86.84
79.3	1.2963	−81.79
99.0	1.2779	−77.58
$C_{20}H_{11}Cl_2O_8$, Dimethyl di-*m*-chlorobenzoyltartrate		
s=EtOH. *c*=1.961		
20	0.7975	86.66
$C_{20}H_{16}Cl_2O_8$, Dimethyl di-*p*-chlorobenzoyltartrate		
11.8	1.3660	−122.20
23.9	1.3536	−118.79
30.4	1.3470	−117.08
35.9	1.3414	−115.50
64.1	1.3127	−103.23
98.0	1.2784	−98.30
s=EtOH. *p*=1.621.		
20	0.7964	−108.1
s=EtOH. *t*=20°		
1.033	0.7777	−72.19
1.3057	.7941	−71.85
1.2592	.7929	−71.38
$C_{20}H_{16}Br_2O_8$, Dimethyl di-*p*-bromobenzoyltartrate		
21.7	1.5832	−112.2
44	1.5565	−107.2
68.5	1.5290	−100.7
74.6	1.5228	−99.1
s=EtOH. *t*=20°		
1.822	0.7982	−101.8
1.766	.7979	−101.5
$C_{20}H_{16}I_2O_8$ Dimethyl di-*o*-iodobenzoyltartrate		
14.1	1.8104	−13.23
20.0	1.8037	−13.82
45.7	1.7746	−16.00
74.7	1.7420	−16.72
99.0	1.7145	−16.47
$C_{20}H_{16}I_2O_8$, Dimethyl di-*m*-iodobenzoyltartrate		
17.8	1.7866	−80.90
35.1	1.7665	−79.18
63.0	1.7335	−74.88
98.5	1.6918	−67.86

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[1] *p* values are in italics.

Rotatory dispersion of d-tartrates in aqueous solutions at 20° C. (**121**)

c λ ↓ c→	$K_2C_4H_4O_6 \cdot ½H_2O$ 4.329 K_2O 0.403	$Na_2C_4H_4O_6 \cdot 2H_2O$ 20.178 Na_2O 0.220	$H_2C_4H_4O_6$ 15.0 As_2O_2 Sat. at B. P.
6,438	−2.62	−14.32	34.68
5,893	−2.71	------	41.55
5,780	−2.71	−19.17	42.87
5,461	−3.71	−22.55	47.83
5,086	−5.52	−27.75	54.33
4,800	−7.24	−33.11	60.35
4,678	−8.96	−35.85	63.02
4,358	−12.12	−46.14	70.62

For further data on these and other metallic salts of tartaric acid see (**83, 107, 113, 114, 115, 143, 144, 208, 218**); also the main table.

Drude's equation
$$\left[M_1\right]_\lambda^t=\frac{k_1}{10^{-8}\,(\lambda^2-\lambda_1^2)}-\frac{k_2}{10^{-8}\,(\lambda^2-\lambda_2^2)}$$

Solute	c	Moles	k_1	k_2	$10^{-8}\lambda_1^2$	$10^{-8}\lambda_2^2$	Range λ
(1) $H_2C_4H_4O_6$	7.5	0.05					
H_3BO_3	4.65	.075	24.08	------	0.0246	------	6,708–4,100
(2) $H_2C_4H_4O_6$	15.0	.10					
H_3BO_2	6.2	.10	25.7	1.249	.03	.065	6,708–4,046
(3) $H_2C_4H_4O_6$	2.5	.0167	------	------	------	------	------
As_2O_2	1.65	.0167	------	------	------	------	------
KOH	14.0	.25	20.148	------	.017	------	6,438–4,259
(4) $H_2C_4H_4O_6$	2.5	.0167	------	------	------	------	------
$Bi(OH)_3$	2.16	.0083	------	------	------	------	------
KOH	14.0	.25	------	37.414	------	.0645	6,438–4,249
(5) $(NH_4)_2C_4H_4O_6$	37.075	------	38.676	17.117	.038	.060	6,438–3,919
(6) $Na_2C_4H_4O_6$	4.6	.02	18.56	------	.000	------	6,438–4,242
NaOH	------	------	------	------	------	------	------
(7) $K_2C_4H_4O_6$	4.7	.02	17.298	------	.013	------	6,438–4,242
KOH	------	------	------	------	------	------	------
(8) $Na_2C_4H_4O_6$	25.72	------	37.445	18.025	.038	.060	6,708–4,005
(9) $Na_2C_4H_4O_6$	41.97	------	37.108	18.348	.038	.060	6,438–3,874
(10) $K_2C_4H_4O_6$	41.647	------	41,750	19.255	.038	.060	6,708–4,046
(11) ------	40.255	------	41.108	18.886	.038	.060	6,438–4,251
(12) $KNaC_4H_4O_6.4H_2O$	55.938	------	38.513	18.066	.038	.060	6,438–4,055
(13) $K(SbO)C_4H_4O_6.½H_2O$	5.516	------	142.78	------	.0494	------	6,708–3,984
(14) $K(SbO)C_4H_4O_6.½H_2O$	5.53	.0167	------	------	------	------	------
KOH	11.2	.20	------	89.48	------	.0627	6,708–4,358

Molecular rotations of the preceding solutions

	6,708	6,438	5,893	5,780	5,461	5,086	4,800	4,678	4,358
(1)	55.9	61.3	74.8	77.8	88.1	103.1	117.2	124.1	145.4
(2)	57.8	63.0	76.7	79.9	90.6	105.9	120.5	128.1	150.2
(3)	------	51.0	------	63.3	72.2	83.8	95.5	99.0	114.9
(4)	------	−106.4	−132.2	−138.8	−159.9	−192.6	−225.5	−243.4	−298.4
(5)	------	54.24	65.43	63.05	76.77	89.10	100.51	106.11	122.83
(6)	------	43.6	------	55.5	62.4	71.7	80.5	84.0	98.7
(7)	------	42.7	------	53.9	61.4	70.8	79.4	84.0	97.3
(8)	45.05	49.00	58.45	60.55	68.23	79.65	89.36	94.51	107.74
(9)	------	47.04	56.10	58.35	65.58	75.88	85.04	89.99	103.04
(10)	51.92	56.51	67.96	70.81	79.61	92.39	104.06	109.63	126.61
(11)	------	55.79	67.20	69.86	78.69	91.26	102.81	108.68	125.22
(12)	------	51.49	61.72	64.29	72.16	83.72	94.41	99.44	114.45
(13)	358.1	389.9	481.0	500.45	573.7	682.2	789.2	842.5	1,015.8
(14)	−229.0	−253.8	−313.7	−330.05	−380.4	−457.8	−534.3	−574.3	−702.0

$C_{12}H_{18}O_8$ *Diethyl diacetyl-d-tartrate* $[\alpha]_\lambda^t$ (205)

	s=Nil				s=$C_2H_4Br_2$. t=76.75					s=C_6H_5OH. t=76.75				
	$[\alpha]^{76.75}$	$[\alpha]^{99.0}$	$[M]^{76.75}$	$[M]^{99.0}$	p=8.43	21.62	53.79	76.58	92.34	30.87	55.45	68.37	84.38	94.58
					d=1.9192	1.7279	1.3996	1.2363	1.1435	1.0509	1.0965	1.0777	1.0901	1.0985
6,527.6	4.833	5.468	14.022	15.864	−1.096	+0.051	+2.312	+3.582	+4.465	+5.003	+3.049	+2.708	+3.233	+4.268
5,890.3	5.173	6.015	15.009	17.452	−2.185	−.819	+2.030	+3.639	+4.622	+5.353	+2.857	+2.474	+3.125	+4.429
5,783.6	5.181	6.086	15.033	17.657	−2.522	−1.070	+1.927	+3.477	+4.592	+5.264	+2.771	+2.338	+3.011	+4.430
5,455.9	5.151	6.135	14.947	17.801	−3.668	−2.008	+1.372	+3.139	+4.476	+3.802	+2.292	+1.801	+2.607	+4.199
4,749.7	3.390	4.815	9.836	13.970	−8.088	−6.116	−1.540	+1.273	+2.747	+3.572	−.426	−1.336	−.066	+2.297
4,364.8		2.303		6.682	−14.224	−11.895					−4.714		−3.909	−.469
4,346.2	.195	2.392	.566	6.941	−14.858	−12.053	−6.499	−2.689	−.458	+.034	−4.997	−5.906	−4.324	−1.539

	s=$C_6H_5NO_2$, Nitrobenzene. t=76.75					s=$C_7H_7NO_2$ *m*-Nitrotoluene. t=76.75					s=$C_{10}H_8$ Naphthalene. t=99				
	p=24.80	52.45	70.91	82.95	92.74	25.92	49.32	67.74	80.77	92.18	31.74	52.89	69.49	82.34	91.92
	d=1.1341	1.1170	1.1216	1.1102	1.1332	1.0652	1.0996	1.0983	1.1007	1.1016	0.9997	1.0217	1.0433	1.0221	1.0705
6,527.6	−7.295	−3.567	−0.707	+1.948	+4.137	−6.624	−2.864	−0.043	+3.479	+4.045	+2.555	+4.307	+4.872	+5.957	+5.596
5,890.3	−10.752	−5.893	−2.032	+1.391	+4.113	−9.698	−4.927	−1.192	+3.139	+4.064	+2.140	+4.364	+5.240	+6.421	+6.177
5,783.6	−11.623	−6.581	−2.470	+1.205	+4.056	−10.524	−5.454	−1.148	+2.972	+3.903	+1.830	+4.143	+5.299	+6.351	+6.244
5,455.9	−14.754	−8.765	−4.086	+.375	+3.784	−13.389	−7.373	−2.796	+2.258	+3.599	+1.035	+3.796	+5.152	+6.532	+6.121
4,749.7	−26.466	−17.357	−7.598	−4.156	+1.404	−24.007	−15.744	−8.754	−1.925	+.994	−2.963	+.958	+2.834	+4.683	+4.888
4,346.2	−24.472	−17.122	−17.088	−10.049	−2.689	−22.192	−14.225	−12.387	−8.221	−3.277	−9.728	−3.654	−.560	+1.570	+2.229

$C_8H_{14}O_6$ *Diethyl d-tartrate* (**153, 154, 155**)

	s	*p*	$[\alpha]_D^{20}$	*t*	$[\alpha]_D^t$	*t*	$[\alpha]_D^t$	*t*	$[\alpha]_D^t$
	Nil	100	7.58	------	------	------	------	------	------
C_2H_3NS	Methyl thiocyanate	60.63	9.87	------	------	------	------	------	------
	Methyl isothiocyanate	61.40	7.95	------	------	------	------	------	------
C_2H_4O	Acetaldehyde	49.09	17.02	------	------	------	------	------	------
C_3H_5NS	Ethyl thiocyanate	9.98	11.7	------	------	------	------	------	------
	Ethyl isothiocyanate	10.17	.37	------	------	------	------	------	------
C_3H_6O	Acetone	10.01	12.2	13	11.7	36.7	13.4	46	13.9
		25.06	11.9	11.5	11.3	32	12.8	36	13.0
C_3H_8O	*n*-Propyl alcohol	25.0	6.73	------	------	------	------	------	------
$C_4H_{10}O$	*n*-Butyl alcohol	12.04	+9.2	------	------	------	------	------	------
	Isobutyl alcohol	10.00	5.7	------	------	------	------	------	------
	sec-Butyl alcohol	11.88	5.7	------	------	------	------	------	------
	tert-Butyl alcohol	12.13	3.5	------	------	------	------	------	------
$C_4H_{10}O_3S$	Diethyl sulphite	9.38	7.9	------	------	------	------	------	------
	Ethyl ethylsulphonate	8.66	4.3	------	------	------	------	------	------
$C_5H_8O_3$	Methyl acetoacetate	10.21	11.3	15.3	10.9	35.1	12.2	54	13.2
		25.23	10.6	16.9	10.4	35.1	11.7	57.3	12.8
		50.46	9.40	15.6	9.0	37.4	10.9	56.2	12.1
C_5H_9NS	Isobutyl thiocyanate	10.59	6.2	------	------	------	------	------	------
	Isobutyl isothiocyanate	10.67	−1.0	------	------	------	------	------	------
$C_5H_{10}O$	Diethyl ketone	11.79	10.5	------	------	------	------	------	------
	Methyl propyl ketone	11.88	10.9	------	------	------	------	------	------
$C_5H_{10}O_3$	Diethyl carbonate	10.11	6.5	------	------	------	------	------	------
C_3H_6O	Allyl alcohol	28.27	11.95	8.6	11.2	35.3	13.2	55.5	14.2
		49.81	10.70	11.5	10.0	34.2	11.9	53.0	13.1
$C_6H_5NO_3$	*o*-Nitrophenol	23.89	------	60.1	16.2	81.4	16.9	112.2	17.66
		51.12	------	56.8	14.31	78.2	15.35	97.3	16.08
		74.95	------	43.4	12.14	87.3	14.38	115.1	14.21
$C_6H_6N_2O_2$	*o*-Nitroaniline	89.3	[1] 12.0	14.4	[1] 11.6	[1] 38.6	[1] 13.5	------	------
	m-Nitroaniline	89.43	[1] 11.8	36.6	[1] 13.1	48.6	[1] 13.8	------	------
	p-Nitroaniline	90.02	[1] 17.8	34.8	[1] 18.0	41.6	[1] 18.2	------	------
C_6H_6O	Phenol	14.79	38.5	30.75	35.47	52.3	30.96	92.4	26.85
		23.85	34.2	53.5	29.55	96.9	25.7	130.4	23.65
		48.2	23.94	65.2	22.62	92.3	21.83	140.6	20.54
		64.78	17.05	64.9	18.38	100.3	18.78	126	18.52
		74.39	13.82	53.5	15.60	76.5	16.38	89.7	16.76
		79.24	12.37	55.5	14.62	87.1	15.90	117.2	16.62
C_6H_7N	Aniline	7.66	37.7	34.7	36.5	59.3	34.2	70.7	33.3
		23.98	35.2	38.1	33.6	55.6	31.3	81.8	29.5
		66.29	21.3	43.2	21.8	75.2	20.8	86.1	20.6
$C_6H_{10}O_3$	Ethyl acetoacetate	10.47	8.9	14	8.0	51	11.7	71.5	13.1
		25.08	8.1	14	7.5	40.5	10.0	50.5	10.8
		50.19	7.7	15.2	7.1	43.1	10.0	54.2	10.9
$C_6H_{12}O_3$	Paracetaldehyde	49.99	3.93	33.1	6.2	57	9.1	67.5	10.0
$C_7H_7NO_3$	*o*-Nitroanisole	9.79	30.6	34.5	29.5	53.2	28.3	62.8	27.7
		21.17	25.3	29.1	25.4	39.3	25.1	55.8	24.8
	p-Nitroanisole	53.84	12.5	35.1	13.63	44.4	14.23	57.6	14.91
C_7H_8O	Anisole	9.99	4.5	27.3	5.34	35.2	6.25	------	------
		24.62	6.8	33.2	8.20	52.9	10.15	72.8	12.41
		49.85	8.1	30.6	9.12	------	------	------	------
C_7H_8O	Benzyl alcohol	10.0	28.0	46.9	26.1	------	------	------	------
		23.38	26.2	45.1	25.2	75.6	23.9	101.1	23.0
	o-Cresol	9.61	33.2	------	------	------	------	------	------
	m-Cresol	9.64	42.6	------	------	------	------	------	------
	p-Cresol	9.59	46.9	------	------	------	------	------	------
C_7H_9N	Methylaniline	9.94	23.6	31.7	23.1	49.8	22.8	65.0	22.5
		30.89	17.6	19.4	17.5	15.7	17.3	15.3	17.3
	o-Toluidine	10.93	30.5	38.2	29.4	47.4	28.3	------	------
		25.10	27.4	45.7	25.7	58.0	25.2	------	------
		50.3	21.1	34.6	20.7	50.5	20.4	------	------
	m-Toluidine	11.66	48.5	29.7	46.1	43.2	42.2	------	------
		24.96	42.4	32.9	39.4	48.0	36.4	64.3	33.9
	p-Toluidine	24.92	42.3	35.7	39.4	46.8	37.7	67.8	33.6
		49.98	31.4	34.7	29.8	46.3	28.6	58.2	27.5
$C_7H_{12}O_3$	Ethyl methylacetoacetate	10.23	8.5	13	7.8	30	9.5	41	10.5
$C_8H_9NO_3$	*o*-Nitrophenetole	25.09	19.2	30.6	19.7	53.3	20.4	65.5	20.6
		39.43	15.75	29.1	16.27	42.0	17.06	------	------
$C_8H_{10}O$	Phenetole	9.99	+7.75	27.1	8.41	36.5	9.58	------	------
		24.96	+7.32	31.6	8.79	43.5	10.14	50.5	10.92
		51.73	6.86	31.0	8.05	18.2	6.72	------	------

[1] See footnote at end of table.

$C_8H_{14}O_6$ Diethyl d-tartrate (**153, 154, 155**)—Continued

	s	*p*	$[\alpha]_D^{20}$	*t*	$[\alpha]_D^t$	*t*	$[\alpha]_D^t$	*t*	$[\alpha]_D^t$
$C_8H_8O_2$	Phenyl acetate	24.96	[1] 5.28	28.2	[1] 5.33	39.3	[1] 5.40	44.4	[1] 5.37
$C_8H_{10}O$	*β*-Phenylethyl alcohol	26.30	[1] 4.48	27.8	[1] 4.52	40.7	[1] 4.55		
$C_8H_{10}O$	*o*-Cresol methyl ether	10.06	8.8						
	m-Cresol methyl ether	10.17	4.9						
	p-Cresol methyl ether	10.04	7.0						
$C_8H_{11}N$	Dimethylaniline	9.4	4.2	26.6	5.6	43.0	7.7	33.9	6.6
		24.84	5.1	30.9	6.6	47.3	8.5	50.9	9.4
$C_8H_{12}O_4$	Ethyl *C*-acetylacetoacetate	9.02	10.0						
	Ethyl *O*-acetylacetoacetate	9.38	14.0						
$C_8H_{14}O_3$	Ethyl ethylacetoacetate	62.93	6.72						
	Ethyl *β*-ethoxycrotonate	62.96	4.86						
	Ethyl dimethylacetoacetate	10.28	8.8	11.9	8.2	35.8	10.1		
		25.17	8.0	13.2	7.1	38.4	9.8	57.1	11.3
		50.31	6.83	12.6	6.5	32.2	8.7	51.0	10.5
$C_9H_{10}O_2$	Benzyl acetate	24.89	[1] 4.68	31.8	[1] 4.72	43.7	[1] 4.75	51.7	[1] 4.82
$C_9H_{12}O$	*γ*-Phenylpropyl alcohol	24.83	[1] 3.63	28.7	[1] 3.73	42.0	[1] 3.87		
	Benzyl ethyl ether	20.78	[1] 2.26	13.0	[1] 2.18	36.3	[1] 2.57	42.5	[1] 2.83
$C_9H_{20}O_4$	Ethyl orthocarbonate	10.80	4.0						
$C_{14}H_{14}O$	Dibenzyl ether	24.84	[1] 3.07	16.4	3.0	32.2	[1] 3.35	40.9	[1] 3.54

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[1] These are values of $\left[\alpha\right]_D^t$ for 10-cm tubes; the specific rotations are not given by the author.

IC$_1$. THE MOLECULE CONTAINS 1 ASYMMETRIC CARBON ATOM ATTACHED TO 3 OTHER CARBON ATOMS

5. CITRONELLAL DERIVATIVES

Derivatives of citronellal (**187; cf. 188, 196**) $\left[a\right]_\lambda^{20}$

		6,563	5,893	5,270	4,861
$C_{11}H_{20}$	2, 6-Dimethyl-$\Delta^{2,\,7}$-nonadiene	−8.12	−10.37	−12.29	−16.17
$C_{12}H_{22}$	2, 6-Dimethyl-$\Delta^{2,\,7}$-decadiene		−6.64		
$C_{13}H_{24}$	2, 6-Dimethyl-$\Delta^{2,\,8}$-undecadiene	−5.22	−6.68	−7.98	−10.55
$C_{13}H_{22}$	2, 6-Dimethyl-$\Delta^{2,\,8,\,10}$-undecatriene	−7.87	−10.12	−12.34	−16.92
$C_{16}H_{28}$	2, 6-Dimethyl-$\Delta^{2,\,8}$-octadiene-8-cyclohexane	−5.03	−6.40	−7.65	
$C_{16}H_{22}$	2, 6-Dimethyl-$\Delta^{2,\,7}$-octadiene-8-benzene	−48.07	−63.24	−77.35	−108.10
$C_{16}H_{24}$	2, 6-Dimethyl-Δ^{2}-octene-8-benzene		−7.26		
$C_{17}H_{24}$	2, 6-Dimethyl-$\Delta^{2,\,8}$-nonadiene-9-benzene		−3.33		
$C_{18}H_{26}$	2, 6-Dimethyl-$\Delta^{2,\,8}$-decadiene-10-benzene	−4.54	−5.76	−6.84	−8.90

6. AMYLACETONE DERIVATIVES

Derivatives of amylacetone $\left[a\right]_\lambda^{20}$ (**204**)

p=10	s	6,563	5,893	5,270	4,861	$[M]_D$
$C_8H_{16}O$ *l*-Amylacetone[1]		6.41	8.20	9.52	12.42	10.49
	C_6H_6	5.4	7.34	8.5	12.5	9.4
	EtOH	6.2	8.0	9.0	13.0	10.3
$C_{10}H_{18}O_2$ Acetyl-*l*-amylacetone		7.54	9.80	11.65	15.78	16.66
	C_6H_6	6.12	8.0	9.5	14.0	14.1
$C_{11}H_{20}O_3$ Ethyl *l*-amylacetoacetate		10.62	13.66	16.23	21.72	27.32
	C_6H_6	10.4	14.1	16.7	23.7	28.2
$C_{15}H_{20}O$ Benzylidene-*l*-amylacetone	C_6H_6	7.8	10.8	12.2	20.0	23.3
$C_{15}H_{20}O_2$ Benzoyl-*l*-amylacetone		7.28	9.41	11.34	15.72	21.83
	C_6H_6	5.1	6.0	8.11	11.94	15.9
	NaOH	6.4	8.93	10.6	15.05	20.7
$C_{16}H_{22}O_2$ Anisylidene-*l*-amylacetone	C_6H_6	5.9	8.62	10.52	16.6	21.2

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[1] These derivatives of *l*-amyl alcohol are dextrorotatory.

IV. Class II. ORGANIC SUBSTANCES, AT LEAST ONE ASYMMETRIC CARBON ATOM OF WHICH FORMS PART OF A RING

II B. THE MOLECULE CONTAINS ASYMMETRIC CARBON ATOMS ATTACHED TO 2 OTHER CARBON ATOMS

7. TETRAHYDRONAPHTHOL AND DERIVATIVES

Specific rotation $[\alpha]_{\lambda}^{t}$ *of d- and l-ac-tetrahydro-β-naphthol and derivatives* (**103**)

t	$C_{10}H_{12}O$ *d-ac*-tetrahydro-*β*-naphthol			$C_{15}H_{20}O_2$ *l-ac*-tetrahydro-*β*-naphthyl *n*-valerate		
	$[\alpha]_{5,893}^{t}$	$[\alpha]_{5,461}^{t}$	$[\alpha]_{4,358}^{t}$	$[\alpha]_{5,893}^{t}$	$[\alpha]_{5,461}^{t}$	$[\alpha]_{4,358}^{t}$
20	75. 68	90. 26	162. 16	−46. 80	−56. 23	−99. 97
40	71. 85	86. 72	155. 51	−45. 77	−55. 34	−98. 40
60	68. 35	82. 62	148. 98	−44. 71	−54. 43	−96. 74
80	65. 36	79. 16	142. 05	−43. 62	−53. 50	−95. 13
100	62. 56	75. 39	135. 65	−42. 48	−52. 52	−93. 40
120	59. 94	72. 33	130. 13	−41. 30	−51. 54	−91. 60
140	57. 50	69. 82	125. 88	−40. 05	−50. 56	−89. 80
160	55. 26	67. 36	121. 04	−38. 79	−49. 53	−87. 96
180	52. 96	64. 66	116. 10	−37. 43	−48. 45	−85. 96
200	50. 86	62. 47	112. 15	----------	----------	----------

s	c	$[\alpha]_{5,893}^{t}$	$[\alpha]_{5,461}^{t}$	$[\alpha]_{4,358}^{t}$
$C_{10}H_{20}O$ *d-ac*-tetrahydro-*β*-naphthol				
Py-----	5. 0815	75. 97	91. 54	164. 6
EtOH--	5. 1565	75. 56	90. 88	161. 4
$CHCl_3$-	4. 9840	67. 32	80. 71	143. 2
CS_2----	5. 1030	62. 30	75. 13	134. 3
C_6H_6---	4. 8265	61. 50	73. 98	131. 6
$C_{18}H_{15}O_4Na$ Sodium *l-ac*-tetrahydro-*β*-napthyl phthalate				
H_2O---	0. 5117	±0°	0. 87	5. 65
	1. 0332	±0°	. 75	4. 84
	1. 5280	−1. 24	−1. 02	1. 10
	1. 9660	−2. 54	−2. 71	−2. 49
EtOH--	. 9423	−18. 05	−21. 59	−34. 26

s	c	$[\alpha]_{5,893}^{t}$	$[\alpha]_{5,461}^{t}$	$[\alpha]_{4,358}^{t}$
$C_{15}H_{20}O_2$ *l-ac*-tetrahydro-*β*-napthyl *n*-valerate				
$CHCl_3$-	4. 9355	−41. 01	−49. 57	−87. 34
EtOH--	5. 0335	−41. 21	−49. 45	−88. 49
C_6H_6---	4, 1395	−53. 63	−64. 63	−115. 1
CS_2----	5. 1460	−63. 86	−77. 36	−140. 0
$C_{18}H_{16}O_4$ *l-ac*-tetrahydro-*β*-naphthyl hydrogen phthalate				
Py-----	5. 2985	−15. 87	−19. 99	−34. 23
EtOH--	4. 9150	−9. 72	−11. 28	−17. 11
$CHCl_3$-	5. 1060	−13. 71	−17. 27	−29. 40
C_6H_6---	2. 2115	−27. 54	−33. 30	−59. 61
$C_{18}H_{16}O_4$ *d-ac*-tetrahydro-*β*-napthyl hydrogen phthalate				
$CHCl_3$---	1. 0718	13. 57	16. 03	28. 84

8. AMINES

$C_{10}H_{14}N_2$ Nicotine (97)

t	d_4^t	$[\alpha]_D^t$
20.0	1.0093	168.20
29.5	1.0017	168.71
41.5	.9924	169.09
52.0	.9840	169.51
62.0	.9760	169.74
69.6	.9699	169.94
86.4	.9567	169.73
92.0	.9521	169.71
s=H_2O		
	p	
20.0	6.638	76.82
85.0	6.638	95.29
20.0	88.338	134.16
90.0	88.338	150.34
20.0	89.471	138.73
20.0	81.842	121.48
20.0	69.202	100.47
20.0	60.773	94.02
20.0	50.134	89.03
20.0	40.237	85.09
20.0	30.973	82.48
20.0	20.726	80.06
20.0	10.012	78.66
20.0	2.505	83.15
s=$CHONH_2$ (231)		
p	d_4^{20}	$[\alpha]_D^{20}$
100	----------	−163.9
61.54	1.0610	−122.65
38.33	1.0889	−102.38
17.80	1.1139	−82.77
11.32	1.1220	−73.74
s=$C_2H_4Br_2$ (231)		
58.12	1.3009	−172.64
36.29	1.5310	−176.55
17.42	1.8096	−179.31
10.14	1.9467	−179.90

Specific rotation $[\alpha]^t_\lambda$ *of nicotine at various temperatures* (**135**)

t	$[\alpha]^t_{4,800}$	t	$[\alpha]^t_{5,893}$
22.3	251.81	22.7	149.97
81.5	223.67	−71.5	135.02
	$[\alpha]^t_{5,086}$	−82.1	131.73
22.4	216.08	−89.0	129.40
81.5	191.27		
	$[\alpha]^t_{5,461}$		$[\alpha]^t_{6,438}$
22.4	180.7	22.5	121.38
5.0	179.40	−71.2	109.51
−5.0	178.20	−80.7	106.98
−15.0	176.90		$[\alpha]^t_{6,708}$
−30.0	174.42	22.5	110.43
−45.0	171.54	−72.2	99.23
−72.5	162.85	−81.6	96.98
−81.5	159.24		
−89.7	156.61		

Specific rotation $[\alpha]^{20}_\lambda$ *of derivatives of l-tetrahydroquinaldine* (**177**; *cf.* **108**)

s	Benzoyl $C_{17}H_{17}NO$				*o*-Nitrobenzoyl $C_{17}H_{16}N_2O_3$			
	c	5,893	5,780	5,461	c	5,893	5,780	5,461
EtOH	1.6890	326.7	342.2	397.3	1.8332	17.11	13.4	−2.05
C_6H_6	1.3396	246.7	258.3	299.9	1.7644	−58.5	−66.8	−99.0
Me_2CO	1.3265	318.1	333.3	389.0	2.1108	9.60	4.5	−12.4
AcOH	1.3309	364.5	382.8	445.2	1.8484	30.0	27.5	+14.5
	m-Nitrobenzoyl $C_{17}H_{16}N_2O_3$				*p*-Nitrobenzoyl $C_{17}H_{16}N_2O_3$			
EtOH	1.7303	241.6	252.8	292.6	1.3376	369.9	388.2	459.2
C_6H_6	1.6752	229.6	241.4	278.8	1.3317	320.7	337.9	396.5
Me_2CO	1.7930	250.7	262.9	306.5	1.3317	353.0	371.7	440.1
AcOH	1.7456	250.2	263.4	306.5	1.3402	379.6	401.8	473.9
	p-Toluyl $C_{18}H_{19}NO$				Toluene-*p*-sulphonyl $C_{17}H_{19}NO_2S$			
EtOH	1.3369	333.2	347.2	404.5	1.3207	−137.2	−143.1	−163.9
C_6H_6	1.3333	251.5	264.4	305.5	1.3029	−134.2	−141.9	−162.7
Me_2CO	1.3426	323.6	338.9	393.7	1.3349	−128.8	−135.2	−155.1
AcOH	1.3472	370.7	388.6	452.0	1.3179	−122.0	−127.1	−145.9
	Nitrobenzene-*m*-sulphonyl $C_{16}H_{16}N_2O_4S$				2-Nitrotoluene-4-sulphonyl $C_{17}H_{18}N_2O_4S$			
EtOH	0.7770	−85.2	−91.7	−103.3	0.6781	−48.7	−49.8	−54.0
C_6H_6	1.4096	−124.2	−130.0	−148.3	1.3212	−21.2	−20.4	−18.9
Me_2CO	1.1664	−100.7	−107.2	−123.9	1.2585	−53.1	−54.4	−60.8
AcOH	1.5098	−96.9	−101.9	−116.9	1.2909	−27.1	−28.1	−30.0

Specific rotation $\left[a\right]_{\lambda}^{20}$ *of derivatives of l-tetrahydroquinaldine* (**177**; *cf.* **108**)—Con.

s	α-Naphthoyl $C_{21}H_{19}NO$				β-Napthoyl $C_{21}H_{19}NO$			
	c	5, 893	5, 780	5, 461	*c*	5, 893	5, 780	5, 461
EtOH	1. 3336	359. 9	416. 2	490. 0	0. 3562	339. 3	359. 5	415. 5
C_6H_6	1. 3192	338. 5	354. 9	421. 7	2. 0434	256. 1	268. 8	311. 5
Me_2CO	1. 3479	385. 8	406. 6	478. 0	. 3376	330. 3	347. 3	405. 1
AcOH	1. 3342	397. 2	420. 3	491. 9	2. 0334	374. 0	393. 8	457. 2
	Naphthalene-α-sulphonyl $C_{20}H_{19}NO_2S$				Naphthalene-β-sulphonyl $C_{20}H_{19}NO_2S$			
EtOH	0. 7949	103. 8	110. 0	134. 9	1. 2570	−225. 0	−237. 3	−276. 1
C_6H_6	1. 3465	75. 0	80. 7	98. 4	1. 3303	−231. 7	−243. 1	−284. 3
Me_2CO	1. 6371	90. 9	94. 7	114. 5	. 6638	−216. 9	−227. 1	−264. 4
AcOH	1. 3596	89. 0	95. 1	114. 7	1. 3522	−206. 5	−216. 5	−252. 5

Specific rotation $\left[a\right]_{\lambda}^{20}$ *of tetrahydroquinaldinomethylene camphors,*[1] $C_{21}H_{27}NO$

$C_{21}H_{27}NO$	s	*c*	5, 893	5, 780	5, 461	4, 482	4, 359
d-T-*d*-C[1]	EtOH	0. 1114	−133	−145	−183		−598
d-T-*d*-C	EtOH	. 5020	−133	−143	−182	M. P.=81. 0°	
d-T-*d*-C (A)	AcOH	. 1052	−95. 5	−105	−136		
d-T-*d*-C	AcOH	. 5009	−142	−153	−196		
l-T-*l*-C	EtOH	. 1108	+134	+144	+182	M. P.=81. 0°	
d-T-*l*-C	EtOH	. 1030	−627	−667	−803	M. P.=111. 5°	
d-T-*l*-C	EtOH	. 5017	−734	−780	−945		
d-T-*l*-C (B)	AcOH	. 1535	−671	−715	−868		
l-T-*d*-C	EtOH	. 1109	+741	+787	+951	+1, 946	+2, 519
l-T-*d*-C	EtOH	. 5008	+734	+780	+945	M. P.=111. 5°	
d-T-*dl*-C	EtOH	. 1016	−440	−475	−577		−1, 575
d-T-*dl*-C (C)	AcOH	. 1062	−384	−412	−504		
l-T-*dl*-C	EtOH	. 1006	+444	+471	+574	M. P.=83. 5°	
dl-T-*d*-C	EtOH	. 1066	+307	+326	+391	M. P.=113. 0°	
dl-T-*l*-C	EtOH	. 1016	−307	−326	−390		−975
dl-T-*l*-C (D)	AcOH	. 1018	−300	−318	−381	M. P.=113. 0°	

[1] T and C represent, respectively, the tetrahydroquinaldinomethylene, $C_{11}H_{13}N$, and the camphor, $C_{10}H_{14}O$, radicals.

NOTE.—Tetrahydroquinaldinomethylene camphors exhibit mutarotation in acetic acid solution. All observations recorded in the above table were made after mutarotation was complete.

Mutarotation of the (A), (B), (C), and (D) substances in the preceding table is given below:

Time (in hours)	(A)	(B)	(C)	(D)
	$\alpha_{5,461}$	$\alpha_{5,461}$	$\alpha_{5,461}$	$\alpha_{5,461}$
½	−2. 54	−19. 60	−8. 15	−5. 44
1½	−2. 00	−18. 25	−7. 39	−5. 34
2½	−1. 91	−17. 88	−7. 25	−5. 26
6½		−17. 77	−7. 20	−5. 18
24			−7. 13	
48	−1. 91			

Data for other smaller concentrations given in the original paper; influence of concentration is negligible.

Salts and derivatives of hydroxyhydrindamine (**173**; *cf.* **172**)

B = 1-hydroxy-2-hydrindamine.
A = α-bromocamphor-π-sulphonic acid.
A′ = camphor-β-sulphonic acid.

Substance	s	$c \diagdown \lambda$	$[\alpha]^{20}_{\lambda}$			$[M]^{20}_{5,461}$
			5,893	5,780	5,461	5,461
d-B-*l*-A [1]	H_2O	1.510	−45.2	−47.7	−56.3	−274
(After 98 hours)*	Me_2CO	.413	−30.9	−32.7	−40.6	−198
d-B-*d*-A	H_2O	1.592	+68.3	71.9	84.5	389
	Me_2CO (95 per cent)	.779	+76.7	81.2	95.3	439
d-B-*d*-A′	H_2O	1.382	+31.7	33.1	38.5	147
	Me_2CO	.686	+69.2	73.2	85.2	325
l-B-*d*-A′	H_2O	2.271	−2.5	−2.4	−1.5	−5.9
(30 minutes)*	Me_2CO	.801	−6.5	−6.5	−7.2	−27.3
(48 hours)*	Me_2CO	-------	−5.3	−5.6	−6.2	−23.7
d-B	H_2O	1.103	+22.9	24.3	27.9	41.6
(122 hours)	Me_2CO	1.053	+275	289	334	498
(104 hours)	EtOH	.518	+39.1	41.1	47.3	70.6
d-B-HCl	H_2O	.642	+32.3	33.9	38.9	72.2
l-B-HCl	H_2O	.606	−32.2	−33.8	−38.8	−72.0
l-B-HBr	H_2O	.502	−26.4	−27.4	−31.9	−73.3
d-B-1/2 (H_2SO_4)	H_2O	1.345	+29.2	30.7	35.3	70.0
(17 hours)*	Me_2CO (70 per cent)	.344	+33.4	34.9	40.7	80.6
-B-HNO_3	H_2O	.718	−27.8	−29.2	−33.8	−71.6
(19 hours)*	Me_2CO (98 per cent)	.341	−52.1	−56.5	−65.3	−138
d-B-1/2 (H_2CO_3)	H_2O	.319	+30.7	33.1	38.0	68.4
d-B-1/2 (H_2PtCl_6)	H_2O	1.200	+16.0	17.3	19.4	68.6
d-B picrate	Me_2CO	.432	-------	-------	-------	-------
(30 minutes)*	Me_2CO	.432	+3.5	+2.9	±0.0	±0.0
(19 hours)*	Me_2CO	.432	−2.9	−4.1	−8.1	−31.0
(43 hours)*	Me_2CO	.432	−4.6	−5.8	−10.4	−39.0
d-B acetate	H_2O	.682	+28.2	30.1	34.5	72.1
(96 hours)*	Me_2CO	.690	+169	177.0	203	425.0
l-B benzoate*	H_2O	.473	−22.2	−23.2	−26.9	−73.0
(107 hours)*	Me_2CO	.486	−122	−128	−148	−401
l-B salicylate*	H_2O	.455	−21.4	−22.0	−25.3	−73
	Me_2CO	.582	-------	-------	-------	-------
(30 minutes)*	Me_2CO	.582	−61.0	−63.5	−73.8	−212
(378 hours)*	Me_2CO	.582	−31.8	−34.3	−39.9	−115
$C_{16}H_{15}NO_2$ *l*- 1-hydroxy-2-benzoylhydrindamine	Me_2CO	.258	−58.1	−60.1	−68.8	−174
$C_{16}H_{15}NO$ *d*-1-hydroxy-2-benzylidenehydrindamine	EtOH	.355	+90.1	95.7	111.0	+262
$C_{10}H_{12}N_2O_2$ *d*-1-hydroxy-2-carbamidohydrindene	AcOH	.386	−4.5	−4.5	−4.5	−8.7
	HCl (conc.)	.422	+59.2	+61.6	+71.7	+138

		s	*c*	λ	$[\alpha]^{20}_{\lambda}$
$C_9H_{12}N_2O$	*l*-1-Hydroxy-2-hydrazinohydrindene (156)	H_2O	0.375	5,893	−14.0
				5,780	−17.6
				5,461	−22.0
$C_{10}H_{13}N_3O_2$	*l*-1-Hydroxy-2-semicarbazinohydrindene	EtOH	0.510	5,461	−14.7

NOTE.—Solutions marked with an asterisk (*) exhibit mutarotation, the final rotation being given for each substance. The form of the rotation-time curve is not simple and a maximum is observed in some cases. Thus the rotations for the dextro-base $(\alpha_{5,461})$ in acetone are:

30 minutes	14.03	42 minutes	14.51	100 minutes	14.73	23 hours	14.34
34 minutes	14.23	55 minutes	14.65	190 minutes	14.69	122 hours	14.07
38 minutes	14.40	70 minutes	14.71	6 hours	14.60	240 hours	14.07

II B_3

(172)			$[\alpha]^{18}_{\lambda}$			$[M]^{18}_{\lambda}$
$C_{18}H_{19}NO_2$ Dihydroxydihydrindamine	s	$c \downarrow$ $\lambda \rightarrow$	5,893	5,780	5,461	5,461
l hydrochloride	H_2O	[1] 0.330	83.3	86.4	100.0	$+28_1$
	H_2O	[1] 2.007	81.3	84.4	98.1	27_6
d hydrochloride	H_2O	[1] .346	−83.2	−86.1	−99.8	$+28_1$
d-chloroplatinate	EtOH	.503	46.3	47.2	55.7	[2] 27_1

	Name	s	*c*	$[\alpha]^{t}_{D}$	Lit.
$C_{17}H_{23}NO_3$	*d*-Hyoscyamine	50 per cent EtOH	4.0	21.0	(29)
	l-Hyoscyamine	50 per cent EtOH	2.165	−25.8	(17)
		$CHCl_3$	4.0	−23.7	(29)
t = room temperature.					

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[1] Concentration calculated on free base.
[2] Molecular rotatory power calculated on one equivalent of base.

IIC. THE MOLECULE CONTAINS ASYMMETRIC CARBON ATOMS ATTACHED EACH TO 3 OTHER CARBON ATOMS

9. METHYLCYCLOHEXANE DERIVATIVES (158)

$C_8H_{13}BrCl_2$ *d*-4-Chloro-1-methyl-4-chlorobromomethylcyclohexane

s	c	t ↓ λ→	4,359	5,780	5,893
EtOH	3.21	17.0	0.39	0.35	0.35

$C_8H_{13}Br$ *d*-1-Methyl-4-bromomethylenecyclohexane[1]

s	c	t ↓ λ→	4,359	5,780	5,893
Ligroin	9.01	16.0	−59.37	−52.34	−50.39
EtOH	3.05	16.0	−62.24	−55.38	−50.40

l-1-Methyl-4-bromomethylenecyclohexane[1]

s	c	t ↓ λ→	4,359	5,780	5,893
Ligroin	9.17	16.0	59.11	52.17	50.18

$C_9H_{13}BrO_2$ *l*-1-Methylcyclohexylidene-4-bromoacetic acid[1]

s	c	t ↓ λ→	4,359	5,780	5,893
EtOH	1.47	19.0	−12.4	−11.0	−10.4
	2.67	16.0	−12.1	−10.6	−10.3

$C_9H_{13}BrCl_2O_2$ *l*-4-Chloro-1-methylcyclohexyl-4-chlorobromoacetic acid

s	c	t ↓ λ→	4,359	5,780	5,893
EtOH	3.79	17.0	−1.32	−1.12	−1.05

$C_9H_{14}Br_2O_2$ *d*-β-Dibromo-1-methylcyclohexyl-4-acetic acid

s	c	t ↓ λ→	4,359	5,780	5,893
EtOAc	1.59	16.0	2.3	2.0	2.4
C_6H_6	1.37	17.0	29.0	25.1	24.3
	1.50	17.0	29.6	25.6	−24.3
	2.70	17.0	28.2	24.5	23.8

$C_9H_{14}Br_2O_2$ *l*-β-Dibromo-1-methylcyclohexyl-4-acetic acid

s	c	t ↓ λ→	4,359	5,780	5,893
EtOAc	3.29	16.0	−2.3	−1.9	−2.3
C_6H_6	1.49	16.0	−29.2	−25.2	−24.5
	3.01	16.0	−28.2	−24.7	−23.9

$C_9H_{14}Br_2O_2$ *l*-α-Dibromo-1-methylcyclohexyl-4-acetic acid[2]

s	c	t ↓ λ→	4,359	5,780	5,893
C_6H_6	1.51	16.0	10.3	9.3	8.6
	3.05	16.0	9.5	8.4	7.6
	3.00	16.0	4.9	4.3	3.9

$C_9H_{14}O_2$ *d*-1-Methylcyclohexylidene-4-acetic acid[1]

s	c	t ↓ λ→	4,359	5,780	5,893
EtOH	0.78	18.0	95.8	83.7	81.1

[1] These compounds are centroasymmetric.

[2] The rotatory powers of the α-dibromides are opposite in sign to those of the parent acids.

10. DIMETHYLTETRAHYDROQUINOLINE AND DERIVATIVES

$C_{11}H_{15}N$ 2, 4–DIMETHYLTETRAHYDROQUINOLINE (216)

	t	$d_4^{t \text{ or } s}$	$[\alpha]_D^t$	$[M]_D^t$
d-	20	1.0009	60.13	97.1
l-	20	1.00078	−57.24	−92.15
d-Iso-	15	1.0044	18.23	29.52
l-Iso-	15	1.0063	−18.03	−29.05
s	*d*-Compound			
EtOH	18	1.473	57.0	91.8
	18	3.675	56.7	91.3
l-Compound				
EtOH	18	1.270	−56.2	−90.6
	18	2.625	−56.0	−90.2
d-Iso-Compound				
EtOH	17	2.102	18.5	29.7
	17	2.768	18.5	29.7
l-Iso-Compound				
EtOH	18	0.951	−17.6	−28.2
	18	2.548	−17.9	−28.8
$C_{11}H_{16}ClN$ *d*-Hydrochloride				
H_2O	18	0.462	84.4	167.0
	18	.908	83.1	164.5
EtOH	19	.422	91.4	181.0
l-Hydrochloride				
H_2O	18	0.583	−81.5	−161.2
	18	.891	−80.8	−159.8
EtOH	18	.541	−91.4	−180.5
	18	.146	−93.2	−184.5
d-Iso-Hydrochloride				
H_2O	18	1.085	5.1	10.1
l-Iso-Hydrochloride				
H_2O	18	1.505	−5.1	−10.1

	t	$d_4^{t \text{ or } s}$	$[\alpha]_D^t$	$[M]_D^t$
$C_{18}H_{19}NO$ Benzoyl-*d*-compound				
C_6H_6	18	0.678	−312.5	−828.0
	18	1.211	−313.7	−831.0
EtOH	18	.501	−379.7	−1,006.0
	18	1.124	−378.9	−1,004.0
Me_2CO	18	.418	−374.5	−992.0
	18	1.162	−377.0	−999.0
$CHCl_3$	18	.426	−373.6	−990.0
	18	.822	−378.1	−1,002.0
AcOEt	18	.392	−397.7	−1,054.0
	18	.768	−392.8	−1,041.0
AcOH	18	.494	−418.2	−1,109.0
	18	.814	−420.6	−1,114.0
Benzoyl-*l*-compound				
C_6H_6	19	0.486	314.1	832.3
	19	.395	314.7	833.7
	19	.809	313.5	830.3
EtOH	18	.363	377.6	1,000.6
AcOH	19	.356	420.0	1,113.0
EtOAc	19	.182	401.7	1,063.0
Benzoyl-*l-Iso*-compound				
EtOH	18		0.0	0.0
$C_{21}H_{30}BrNO_4S$ *d*-2, 4-Dimethyltetrahydroquinoline *d*-α-bromocamphor-π-sulphonate				
H_2O	18	0.416	86.2	407.0
	18	.821	84.9	401.0
	18	1.236	85.0	401.0
	18	1.640	86.5	408.0
d-Iso-l-compound				
H_2O	18	1.286	−55.2	−261.0
	18	1.341	−54.8	−259.0
	18	.886	−55.4	−262.0
	18	.456	−55.5	−262.0
l-l-compound				
H_2O	18	0.450	−85.5	−404.0
	18	.854	−86.1	−407.0
	18	1.913	−84.7	−400.0
l-Iso-d-compound				
H_2O	18	1,034	55.7	263.0

11. MYRTENOL ESTERS

(188) Esters of myrtenol $[\alpha]_\lambda^{20}$

Formula	Name	6,563	5,893	5,463	4,861
$C_{10}H_{16}O$	Myrtenol	36.83	46.49	55.04	71.81
$C_{14}H_{20}O_2$	Myrtenyl crotonate	32.39	40.97	48.66	63.75
$C_{14}H_{22}O_2$	Myrtenyl butyrate	26.99	34.13	40.51	53.01
$C_{16}H_{22}O_2$	Myrtenyl $\Delta^{1,3}$ pentadiene-α-carboxylate	29.25	36.97	43.96	57.36
$C_{16}H_{26}O_2$	Myrtenyl *n*-hexoate	23.95	30.30	35.96	47.13
$C_{17}H_{20}O_2$	Myrtenyl benzoate	29.01	36.67	43.51	56.90
$C_{18}H_{22}O_2$	Myrtenyl phenylacetate	20.31	25.68	30.35	39.42
$C_{19}H_{24}O_2$	Myrtenyl β-phenylpropionate	20.77	26.30	31.22	40.81

12. MENTHONE

Specific rotation $[\alpha]_\lambda^t$ *of menthone* $C_{10}H_{18}O$ *at different temperatures* (**104**)

λ t	5,893	5,780	5,461	4,358	λ t	5,893	5,780	5,461	4,358
20	−26.74	−27.84	−32.07	−57.15	120	−31.41	−32.88	−38.18	−71.83
40	−27.65	−28.89	−33.29	−59.92	140	−31.63	−33.13	−38.63	−72.13
60	−28.36	−29.79	−34.38	−62.61	160	−31.48	−33.06	−38.43	−71.48
80	−29.32	−30.67	−35.48	−65.55	180	−31.77	−33.09	−38.37	−71.52
100	−30.43	−31.77	−36.82	−68.84					

Anomalous rotatory dispersion of mixtures of $C_{10}H_{18}O$ *l- and d-menthone* (**36**; *cf.* **13, 19, 20, 21, 69**)

l-Menthone *p*	*d*-Menthone *p*	$[\alpha]_\lambda^{20}$			
		6,563	5,893	5,270	4,861
100	----------	−22.44	−28.84	−37.75	−46.47
	100	19.33	26.83	38.66	52.45
46.29	53.71	.085	1.00	3.04	6.03
40.21	59.79	2.37	4.05	7.22	11.43
51.76	48.24	−1.94	−1.70	−.69	1.18
59.24	40.76	−4.73	−5.41	−5.77	−5.41

IICB. THE MOLECULE CONTAINS 2 OR MORE ASYMMETRIC ATOMS ATTACHED RESPECTIVELY TO 2 AND 3 OTHER CARBON ATOMS

13. MENTHOL, ISOPULEGOL, AND DERIVATIVES

$C_{10}H_{20}O$ *l-Menthol* $[\alpha]_D^{18}$ **(68)**

s- p	Phenol C_6H_5OH	Eugenol $C_{10}H_{12}O_2$	s- p	Phenol C_6H_5OH	Eugenol $C_{10}H_{12}O_2$
10	------------	−48.96	35	−46.51	−47.84
15	------------	−48.52	40	−46.44	−47.73
25	−47.16	−48.13	45	−46.39	−47.63
30	−46.74	−47.98	50	−46.36	−47.56

$C_{17}H_{23}NO_4$ *l-Menthyl o-nitrobenzoate* **(49)**

	d^t	$[\alpha]_D^t$	t	d^t	$[\alpha]_D^t$
100	1.050	−121.2	*p*-Ester		
80	1.058	−125.0			
70	1.073	−124.6			
65	1.078	−124.8	100	1.045	−75.48
m-Ester			80	1.058	−76.21
			70	1.070	−76.54
			65	1.077	−76.94
100	1.049	−82.04			
80	1.056	−82.92			
70	1.071	−82.54			
65	1.081	−82.06			
40	1.097	−82.17			
20	1.118	−82.52			

Specific rotation $[\alpha]^t_\lambda$ *of menthol and related compounds at different temperatures*
(104)

λ / t	5,893	5,780	5,461	4,358	5,893	5,780	5,461	4,358
	$C_{10}H_{20}O$ *l*-Menthol				$C_{10}H_{21}N$ *l*-Menthylamine			
20	−48.96	−51.39	−57.90	−96.61	−39.97	−41.63	−47.04	−76.40
40	−49.55	−52.10	−58.80	−97.61	−40.81	−42.51	−48.07	−78.03
60	−50.02	−52.34	−59.30	−98.15	−41.52	−43.24	−48.88	−79.47
80	−49.97	−52.06	−58.95	−97.97	−42.14	−43.96	−49.58	−80.85
100	−49.48	−51.53	−58.21	−97.03	−42.76	−44.62	−50.27	−82.22
120	−48.78	−50.94	−57.48	−95.82	−43.40	−45.21	−51.01	−83.75
140	−48.15	−50.34	−56.78	−94.66	−44.01	−45.75	−51.69	−85.09
160	−47.58	−49.76	−56.14	−93.46	−44.61	−46.20	−52.32	−86.52
180	−47.09	−49.09	−55.59	−92.04	−45.02	−46.69	−52.81	−87.78
	$C_{12}H_{22}O_2$ *l*-Menthyl acetate				$C_{17}H_{23}NO_4$ *l*-Menthyl *o*-nitrobenzoate			
20	−79.41	−83.01	−94.12	−156.1	−128.7	−136.4	−161.3	−381.9
40	−79.20	−82.73	−93.58	−155.7	−126.1	−133.8	−157.9	−372.7
60	−78.98	−82.47	−93.50	−155.2	−123.6	−131.0	−154.4	−362.9
80	−78.89	−82.31	−93.28	−155.1	−121.2	−128.1	−151.0	−352.4
100	−78.57	−81.98	−92.90	−154.4	−119.0	−125.2	−147.6	−341.8
120	−78.34	−81.74	−92.64	−153.9	−117.3	−123.4	−145.5	--------
140	−78.11	−81.51	−92.34	−153.4	−115.9	−122.1	−143.9	--------
160	−77.89	−81.26	−92.04	−152.9	−114.4	−120.7	−142.1	--------
180	−77.62	−81.00	−91.70	−152.4	−112.9	−119.3	−140.2	--------
	$C_{17}H_{23}NO_4$ *l*-Menthyl *m*-nitrobenzoate				$C_{17}H_{32}NO_4$ *l*-Menthyl *p*-nitrobenzoate			
20	−82.52	−86.30	−98.44	−173.6	−70.99	−73.98	−83.33	--------
40	−82.14	−85.93	−97.90	--------	−70.86	−73.91	−83.45	--------
60	−81.70	−85.43	−97.25	--------	−70.73	−73.72	−83.28	--------
80	−81.06	−84.76	−96.44	--------	−70.60	−73.57	−83.12	--------
100	−80.39	−84.00	−95.72	--------	−70.34	−73.40	−82.83	--------
120	−79.68	−83.28	−94.95	--------	−70.18	−73.16	−82.59	--------
140	−78.93	−82.59	−94.18	--------	−69.98	−73.05	−82.47	--------
160	−78.42	−82.27	−93.66	--------	−69.98	−71.86	−81.64	--------
180	−78.70	−82.56	−93.65	--------	−67.33	−70.44	−79.50	--------
	$C_{18}H_{26}O_2$ *l*-Menthyl phenylacetate				$C_{18}H_{26}O_3$ *l*-Menthyl *p*-methoxybenzoate			
20	−68.06	−71.34	−81.14	−137.4	−86.22	−90.12	−102.6	−174.7
40	−67.41	−70.44	−80.09	−135.6	−87.42	−90.38	−103.6	−175.7
60	−66.65	−69.56	−79.07	−133.8	−85.39	−89.43	−101.4	−170.1
80	−65.66	−68.58	−77.87	−131.9	−83.52	−87.44	−99.04	−167.2
100	−64.74	−67.54	−76.72	−130.0	−81.64	−85.31	−96.70	−163.2
120	−63.89	−66.62	−75.80	−128.1	−79.82	−83.45	−94.64	−159.1
140	−62.95	−65.67	−74.87	−126.1	−78.03	−81.68	−92.47	−155.4
160	−62.07	−64.92	−73.91	−123.9	−76.28	−79.79	−90.28	−151.9
180	−61.55	−64.40	−73.02	−121.9	−74.87	−78.00	−88.35	−148.7

	$C_{22}H_{38}O_4$ *l*-Dimenthyl oxalate			
20	−93.46	−97.61	−110.4	−182.0
40	−93.28	−97.40	−110.1	−181.9
60	−93.11	−97.21	−109.9	−181.5
80	−92.87	−96.99	−109.6	−181.0
100	−92.64	−96.61	−109.2	−180.3
120	−92.10	−96.10	−108.8	−179.6
140	−91.68	−95.43	−108.1	−178.9
160	−91.11	−94.77	−107.4	−178.0
180	−90.38	−94.04	−106.6	−177.0

19°	$C_{17}H_{23}IO_2$ *l*-Menthyl *o*-iodobenzoate			
	−61.35 −61.02	−64.30 −63.90	−73.57 −73.16	−130.8 −130.4
19°	$C_{17}H_{33}IO_2$ *l*-Menthyl *m*-iodobenzoate			
	−61.22	−63.90	−72.67	−121.8
19°	$C_{17}H_{33}IO_2$ *l*-Menthyl *p*-iodobenzoate			
	−63.63	−66.50	−75.30	−126.7
20°	$C_{20}H_{28}O_3$ *l*-Menthyl *p*-allyloxybenzoate			
	−79.76	−83.55	−94.14	164.6

Esters of l-Isopulegol $[\alpha]_\lambda^t$ (160)

Formula	Name	t°	6, 438	5, 461	5, 086	4, 800	4, 359
$C_{10}H_{18}O$	*l*-Isopulegol	20	−18.23	−25.90	−30.31	−34.51	−43.07
		40	18.61	26.46	31.01	35.43	44.30
		60	18.98	27.05	31.74	36.37	45.55
		80	19.39	27.65	32.47	37.35	46.86
		100	19.83	28.28	33.25	38.37	48.22
		120	20.26	28.95	34.08	39.45	49.67
		140	20.73	29.66	34.95	40.57	51.16
		160	21.22	30.38	35.83	41.74	52.71
$C_{12}H_{20}O_2$	*l*-Isopulegyl acetate	20	−9.58	−12.22	−13.61	−14.57	−15.65
		40	−11.61	−15.32	−17.18	−18.71	−21.24
		60	−13.65	−18.34	−20.74	−22.83	−26.38
		80	−15.82	−21.23	−24.16	−26.95	−31.56
	(*s*=EtOH, *c*=5)	20	−16.66	−20.66	−23.95	−26.55	−29.44
$C_{13}H_{22}O_2$	*l*-Isopulegyl propionate	20	−8.19	−10.13	−11.06	−11.63	−12.20
		40	−10.17	−13.49	−14.80	−16.12	−17.98
		60	−12.22	−16.58	−18.51	−20.36	−23.54
		80	−14.33	−19.63	−22.21	−24.68	−29.04
	(*s*=EtOH, *c*=5)	20	−15.81	−19.64	−22.87	−25.08	−27.70
$C_{14}H_{24}O$	*l*-Isopulegyl *n*-butyrate	20	−5.53	−6.46	−7.02	−6.93	−6.28
		40	−7.78	−9.99	−10.98	−11.77	−12.34
		60	−9.87	−13.32	−14.69	−16.13	−18.10
		80	−11.87	−16.24	−18.35	−19.88	−23.41
		100	−14.12	−19.39	−22.41	−24.65	−29.09
		120	−16.31	−22.40	−26.00	−28.77	−34.59
		140	−18.21	−25.54	−29.34	−32.96	−39.86
		160	−20.12	−28.60	−32.77	−37.20	−45.24
	(*s*=EtOH, *c*=5)	20	−14.11	−16.50	−19.19	−20.67	−23.56
$C_{15}H_{26}O_2$	*l*-Isopulegyl *n*-valerate	20	−6.28	−7.57	−8.28	−8.57	−8.63
		40	−8.39	−10.87	−11.99	−12.87	−14.16
		60	−10.32	−13.78	−15.47	−17.12	−19.36
		80	−12.19	−16.51	−18.79	−20.95	−24.11
	(*s*=EtOH, *c*=5)	20	−14.28	−16.79	−19.71	−21.62	−24.13
$C_{16}H_{28}O_2$	*l*-Isopulegyl caproate	20	−5.19	−5.95	−6.19	−6.30	−5.84
		40	−7.45	−9.04	−9.84	−10.46	−11.46
		60	−9.33	−11.93	−13.31	−14.55	−16.66
		80	−11.06	−14.86	−16.77	−18.41	−21.47
	(*s*=EtOH, *c*=5)	20	−11.37	−14.36	−17.12	−18.79	−21.07
$C_{17}H_{30}O_2$	*l*-Isopulegyl enanthate	20	−4.84	−5.48	−5.76	−5.83	−5.50
		40	−6.71	−8.45	−9.44	−10.07	−10.74
		60	−8.43	−11.27	−12.57	−13.82	−15.41
		80	−10.17	−13.88	−15.68	−17.53	−20.00
	(*s*=EtOH, *c*=5)	20	−10.81	−13.82	−15.92	−17.12	−19.83
$C_{18}H_{32}O_2$	*l*-Isopulegyl caprylate	20	−4.60	−5.23	−5.68	−5.86	−5.26
		40	−6.58	−7.92	−8.84	−9.68	−10.10
		60	−8.28	−10.52	−11.88	−13.23	−14.82
		80	−9.78	−13.09	−14.84	−16.69	−19.07
	(*s*=EtOH, *c*=5)	20	−10.30	−13.50	−15.10	−16.81	−19.21
$C_{19}H_{34}O_2$	*l*-Isopulegyl pelargonate	20	−4.36	−4.98	−5.38	−5.51	−4.94
		40	−6.20	−7.64	−8.43	−9.22	−9.47
		60	−7.72	−10.24	−11.39	−12.64	−13.94
		80	−9.20	−12.57	−14.06	−15.62	−18.12
	(*s*=EtOH, *c*=5)	20	−10.21	−13.01	−14.81	−16.31	−18.72
$C_{20}H_{36}O_2$	*l*-Isopulegyl caprate	20	−4.15	−4.93	−5.20	−5.35	−5.15
		40	−5.78	−7.52	−8.19	−8.71	−9.66
		60	−7.41	−9.75	−11.10	−12.23	−13.54
		80	−9.02	−11.92	−13.69	−15.20	−17.38
	(*s*=EtOH, *c*=5)	20	−9.77	−12.47	−14.16	−15.65	−17.55
$C_{21}H_{38}O_2$	*l*-Isopulegyl undecylate	20	−4.31	−4.98	−5.29	−5.54	−5.54
		40	−5.94	−7.35	−8.21	−8.94	−9.41
		60	−7.31	−9.48	−10.83	−11.82	−13.18
		80	−8.65	−11.48	−13.02	−14.52	−16.44
	(*s*=EtOH, *c*=5)	20	−9.86	−11.87	−13.68	−15.39	−16.40
$C_{22}H_{40}O_2$	*l*-Isopulegyl laurate	20	−3.84	−4.42	−4.83	−4.98	−4.65
		40	−5.35	−6.69	−7.60	−8.23	−8.57
		60	−6.89	−8.88	−10.14	−11.18	−12.27
		80	−8.32	−11.01	−12.47	−13.75	−15.93
	(*s*=EtOH, *c*=5)	20	−9.44	−11.90	−13.56	−15.04	−16.51
$C_{24}H_{44}O_2$	*l*-Isopulegyl myristate	20	−3.81	−4.23	−4.68	−4.84	−4.48
		40	−5.30	−6.30	−7.05	−7.62	−8.07
		60	−6.63	−8.32	−9.38	−10.28	−11.44
		80	−7.82	−10.33	−11.69	−13.00	−15.02
	(*s*=EtOH, *c*=5)	20	−9.24	−10.95	−12.76	−14.16	−15.46

Menthol and related compounds in solution $[\alpha]_{\lambda}^{t}$ (**104;** *cf.* **12, 71, 136, 185, 191**)

t=approximately 20°

Formula	Name	s	c	5,893	5,780	5,461	4,358
$C_{10}H_{18}O$	*l*-Menthone	C_6H_6	5. 01	16. 73	17. 13	19. 83	35. 17
		EtOH	5. 49	23. 19	24. 02	27. 66	47. 31
		CS_2	5. 47	23. 95	24. 86	29. 07	58. 68
$C_{10}H_{20}O$	*l*-Menthol	EtOH	5. 16	−49. 46	−51. 80	−59. 14	−97. 09
		CS_2	5. 28	47. 03	49. 11	55. 64	93. 19
		C_6H_6	5. 53	44. 60	46. 52	52. 78	86. 78
$C_{12}H_{22}O_2$	*l*-Menthyl acetate	CS_2	5. 18	77. 01	81. 27	91. 20	150. 58
		EtOH	5. 79	85. 23	89. 02	100. 93	167. 50
$C_{14}H_{24}O_4$	*l*-Menthyl hydrogen succinate (*Cf.* 12).	C_6H_6	5. 08	59. 43	62. 24	70. 47	116. 27
		$CHCl_3$	5. 09	65. 65	68. 50	78. 05	128. 91
$C_{17}H_{22}BrClO_2$	*l*-Menthyl 2-chloro-6-bromobenzoate.	CS_2	4. 77	15. 69	16. 74	19. 04	33. 88
$C_{17}H_{22}ClNO_4$	*l*-Menthyl 4-chloro-2-nitrobenzoate.	CS_2	4. 12	144. 64	152. 76	181. 74	447. 38
$C_{17}H_{22}ClNO_4$	*l*-Menthyl 4-chloro-3-nitrobenzoate.	Py	4. 60	72. 57	75. 19	85. 41	155. 39
$C_{17}H_{22}ClNO_4$	*l*-Menthyl 5-chloro-2-nitrobenzoate.	CS_2	4. 52	151. 53	161. 25	193. 97	516. 14
		C_6H_6	4. 86	169. 38	180. 86	217. 30	566. 79
		$CHCl_3$	5. 46	153. 71	162. 40	195. 23	505. 03
$C_{17}H_{22}N_2O_6$	*l*-Menthyl 2, 6-dinitrobenzoate.	C_6H_6	4. 72	184. 05	196. 83	237. 49	644. 60
$C_{17}H_{22}N_2O_6$	*l*-Menthyl 3, 5-dinitrobenzoate.	$CHCl_3$	4. 64	80. 39	83. 32	96. 03	173. 83
$C_{17}H_{22}N_2O_6$	*l*-Menthyl 2, 4-dinitrobenzoate.	Py	4. 73	116. 0	122. 6	145. 0	347. 62
		CS_2	4. 83	133. 3	141. 2	167. 9	403. 11
		$CHCl_3$	4. 94	135. 9	144. 0	170. 9	403. 76
		C_6H_6	4. 80	138. 1	146. 1	173. 6	425. 68
$C_{17}H_{23}ClO_2$	*l*-Menthyl *m*-chlorobenzoate.	CS_2	5. 67	85. 19	89. 07	100. 13	171. 80
$C_{17}H_{23}FO_2$	*l*-Menthyl *p*-fluorobenzoate.	Py	5. 31	81. 45	84. 94	96. 14	160. 58
		$CHCl_3$	4. 84	81. 70	85. 41	96. 56	159. 87
		EtOH	4. 73	84. 37	87. 62	99. 33	165. 57
		CS_2	4. 55	90. 24	93. 33	106. 72	181. 38
		C_6H_6	4. 82	86. 80	90. 74	102. 86	173. 09
$C_{17}H_{23}IO_2$	*l*-Menthyl *o*-iodobenzoate	CS_2	5. 17	58. 59	61. 76	70. 34	124. 49
$C_{17}H_{23}IO_2$	*l*-Menthyl *m*-iodobenzoate	Py	5. 28	58. 38	62. 37	68. 96	115. 20
		CS_2	6. 19	63. 97	66. 24	74. 80	127. 77
$C_{17}H_{23}IO_2$	*l*-Menthyl *p*-iodobenzoate	AcOEt	6. 06	57. 36	59. 91	67. 72	111. 61
		C_6H_6	5. 71	69. 69	72. 14	82. 13	139. 73
$C_{17}H_{23}NO_4$	*l*-Menthyl *o*-nitrobenzoate	Py	5. 07	138. 91	146. 90	175. 00	435. 52
		$CHCl_3$	5. 15	154. 01	162. 01	170. 67	461. 97
		EtOH	4. 92	156. 78	165. 52	195. 57	466. 90
		CS_2	5. 57	162. 76	172. 27	208. 08	513. 34
		C_6H_6	4. 19	182. 40	193. 47	230. 27	560. 18
$C_{17}H_{23}NO_4$	*l*-Menthyl *m*-nitrobenzoate.	Py	5. 87	81. 75	85. 67	97. 76	173. 34
		CS_2	7. 11	88. 97	92. 83	106. 48	186. 09
$C_{17}H_{24}O_2$	*l*-Menthyl benzoate	C_6H_6	5. 20	90. 38	96. 01	106. 70	178. 60
		$CHCl_3$	5. 18	86. 61	90. 66	102. 24	169. 75
$C_{17}H_{25}NO_2$	*l*-Menthyl phenylcarbamate.	$CHCl_3$	4. 96	76. 91	80. 04	91. 83	153. 22
$(C_{18}H_{23}O_4)_2Mg$	Magnesium *l*-menthyl phthalate.	EtOH	3. 76	55. 23	57. 62	65. 06	108. 88
$C_{18}H_{23}O_4Na$	Sodium *l*-menthyl phthalate.	H_2O	5. 29	60. 74	63. 42	72. 52	123. 79
$C_{18}H_{24}O_4$	*l*-Menthyl hydrogen phthalate.	$CHCl_3$	4. 97	93. 74	97. 86	113. 15	205. 19
$C_{18}H_{26}O_2$	*l*-Menthyl phenylacetate	C_6H_6	5. 07	64. 43	67. 39	76. 26	128. 45
$C_{18}H_{26}O_2$	*l*-Menthyl *m*-toluate	C_6H_6	5. 03	88. 47	92. 17	104. 99	176. 63
$C_{20}H_{30}O_3$	*l*-Menthyl *o*-propoxybenzoate.	CS_2	4. 89	59. 82	62. 37	70. 34	115. 45
$C_{20}H_{30}O_3$	*l*-Menthyl *p*-isopropoxybenzoate.	C_6H_6	4. 78	79. 56	83. 22	94. 58	161. 41
$C_{20}H_{38}O_3S$	*di*-*l*-Menthyl sulphite	EtOH	4. 92	78. 81	81. 75	93. 22	155. 90
$C_{22}H_{28}O_3$	*l*-Menthyl 2-methoxynaphthoate.	CS_2	4. 95	46. 89	49. 32	56. 39	89. 33
		C_6H_6	5. 02	51. 16	53. 43	60. 75	99. 79
$C_{22}H_{38}O_4$	*l*-Dimenthyl oxalate	EtOH	5. 27	97. 86	101. 84	115. 57	192. 12
		CS_2	4. 79	82. 08	85. 82	96. 68	157. 99
		C_6H_6	4. 92	98. 18	102. 55	116. 25	192. 81
		Py	4. 74	93. 69	97. 43	110. 83	183. 84
$C_{23}H_{29}NO_4$	Pyridinium *l*-menthyl phthalate.	Py	6. 57	70. 92	74. 57	86. 30	159. 74

Menthylamine derivatives $[\alpha]_{\lambda}^{t}$ (**104**; *cf.*, **12, 71, 136, 185, 191**)

t=approximately 20°

Formula	Name	s	c	5, 893	5, 780	5, 461	4, 358
$C_{10}H_{22}ClN$	*l*-Menthylamine hydrochloride	H_2O	5. 12	36. 29	37. 45	42. 60	69. 85
		$CHCl_3$	4. 98	45. 72	49. 86	54. 14	89. 82
$C_{13}H_{25}NO_2$	Ethyl *l*-menthylcarbamate	$CHCl_3$	3. 94	68. 52	71. 31	81. 58	137. 0
$C_{14}H_{25}NO_2$	Allyl *l*-menthylcarbamate	EtOH	4. 35	67. 33	70. 08	79. 86	135. 98
$C_{14}H_{28}N_2O$	*n*-Propyl-*l*-menthylcarbamide	$CHCl_3$	2. 77	66. 94	69. 47	79. 20	133. 17
$C_{15}H_{29}NO_2$	*n*-Butyl *l*-menthylcarbamate	$CHCl_3$	4. 42	64. 18	66. 74	76. 19	128. 76
$C_{18}H_{27}NO_2$	*m*-Tolyl *l*-menthylcarbamate	$CHCl_3$	2. 93	56. 14	59. 20	66. 70	115. 35
$C_{18}H_{27}NO_2$	*p*-Tolyl *l*-menthylcarbamate	$CHCl_3$	1. 96	56. 49	58. 52	66. 92	112. 98
$C_{18}H_{28}N_2O$	*m*-Tolyl-*l*-menthylcarbamide	Py	2. 23	80. 67	85. 06	97. 03	171. 32
$C_{19}H_{29}NO_2$	*m*-4-Xylenyl *l*-menthylcarbamate	$CHCl_3$	3. 85	53. 91	55. 67	63. 57	108. 05
$C_{21}H_{27}NO_2$	1-Naphthyl *l*-menthylcarbamate	EtOH	3. 10	48. 66	51. 86	59. 64	100. 20
$C_{21}H_{28}N_2O$	2-Naphthyl-*l*-menthylcarbamide	$CHCl_3$	1. 13	64. 68	67. 89	76. 72	136. 18
$C_{21}H_{39}NO_2$	*l*-Menthyl *l*-menthylcarbamate	$CHCl_3$	4. 74	90. 02	93. 60	106. 34	178. 26
$C_{21}H_{40}N_2O$	di-*l*-Menthylcarbamide	$CHCl_3$	4. 68	91. 26	95. 53	108. 02	181. 25

Rotatory dispersion of some menthyl esters (**197**; *cf.*, **38**)

Formula	Name	s	t	p or c	6, 563	5, 893	5, 461	4, 861
$C_{13}H_{21}NO_2$	*l*-Menthyl cyanoacetate	C_6H_6	20	*10*	−64. 15	−80. 92	−95. 21	−123. 57
$C_{16}H_{26}O_4$	*l*-Menthyl acetylacetoacetate.	Nil			−61. 49	−79. 56	−96. 34	−131. 32
		C_6H_6		*10*	−40. 39	−50. 77	−59. 46	−76. 50
$C_{16}H_{28}O_3$	*l*-Menthyl ethylacetoacetate.	C_6H_6		*10*	−50. 59	−63. 85	−75. 60	−98. 39
$C_{17}H_{30}O_3$	*l*-Menthyl isopropylacetoacetate.	Nil	20		−48. 69	−61. 53	−72. 91	−95. 05
		C_6H_6	20	*10*	−47. 32	−59. 74	−70. 58	−91. 70
$C_{18}H_{26}O_2$	Menthyl *o*-toluate (38)	Nil	20		−66. 54	−84. 58	−108. 84	−131. 72
$C_{19}H_{24}O_2$	*l*-Menthyl phenylpropiolate.	C_6H_6		*10*	−57. 31	−72. 56	−85. 90	−111. 92
$C_{19}H_{26}O_3$	*l*-Menthyl benzoylacetate	C_6H_6	20	*10*	−50. 95	−64. 39	−76. 15	−99. 89
$C_{21}H_{28}O_3$	*l*-Menthyl benzylideneacetoacetate (cf. 82).	C_6H_6		*10*	−8. 17	−10. 97	−13. 66	−21. 27
$C_{21}H_{30}O_3$	*l*-Menthyl *l*-benzylacetoacetate.	C_6H_6	20	*10*	−94. 05	−121. 21	−145. 67	−196. 73
	l-Menthyl *dl*-benzylacetoacetate.	C_6H_6	20	*10*	−43. 43	−55. 10	−65. 20	−85. 85
$C_{25}H_{30}O_3$	*l*-Menthyl benzoylphenylacetate.	C_6H_6	20	*10*	13. 73	21. 10	28. 58	49. 91
		EtOH	20	*10+1* drop py	−43. 89	−58. 91	−75. 08	−93. 57
$C_{26}H_{30}O_3$	*l*-Menthyl benzoylbenzylideneacetate.	C_6H_6	20	*10*	−61. 75	−78. 62	−93. 69	−123. 84
$C_{27}H_{34}O_3$	*l*-Menthyl *d*-diphenylmethylacetoacetate.	C_6H_6		*10*	−33. 83	−41. 94	−48. 18	−60. 00
	l-Menthyl *l*-diphenylmethylacetoacetate.	C_6H_6		*10*	−51. 13	−65. 15	−78. 04	−103. 94
	l-Menthyl *dl*-diphenylmethylacetoacetate.	C_6H_6		*10*	−42. 62	−53. 69	−63. 31	−82. 43
$C_{28}H_{34}O_3$	*l*-Menthyl *l*-benzoylcinnamylacetate.	C_6H_6	20	*10*	−67. 41	−86. 08	−102. 18	−135. 71
$C_{30}H_{34}O_2$	*l*-Menthyl triphenylacetate (38).	PhMe	20	[1] 26. 17	−3. 04	−3. 44	−3. 67	−3. 63
		CS_2	20	[1] 19.22	−9. 94	−13.79	−19. 65	−25. 97
		Me_2CO	20	[1] 12. 89	−1. 58	−1. 58	−1. 28	−. 70
		$CHCl_3$	20	[1] 18. 12	−3. 81	−4. 39	−4. 88	−5. 18

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[1] For this compound c=g/100 cc.

Menthol and menthyl esters $[\alpha]_{\lambda}^{20}$

Formula	Name	p	s	6,563	5,893	5,463	4,861	Lit.
$C_{10}H_{20}O$	*l*-Menthol	----	C_6H_6	37.01	46.58	54.78	70.84	**188**
$C_{13}H_{21}NO_2$	*l*-Menthyl cyanoacetate	10	C_6H_6	−64.15	80.92	95.21	123.57	**197**
$C_{14}H_{24}O_3$	*l*-Menthyl acetoacetate	---	Nil	−54.92	−69.21	−81.98	−106.35	**188**
		10	C_6H_6	−55.71	−69.32	−82.15	−105.78	**204**
		---	C_6H_6	--------	−68.08	--------	--------	**188**
		---	EtOH	--------	−70.26	--------	--------	**188**
$C_{14}H_{26}O_2$	*l*-Menthyl butyrate	----	Nil	55.39	69.66	82.13	106.16	**188**
$C_{15}H_{28}O_2$	*l*-Menthyl isovalerate	----	Nil	51.88	65.18	76.95	99.09	**188**
$C_{16}H_{26}O_4$	*l*-Menthyl acetylacetoacetate	---	Nil	61.49	−79.56	−96.34	−131.32	**197**
		10	C_6H_6	−51.84	−66.88	−80.68	−110.64	
$C_{16}H_{28}O_3$	*l*-Menthyl ethylacetoacetate	----	Nil	−50.59	−63.85	−75.60	−98.39	**188, 197**
$C_{17}H_{24}O_2$	*l*-Menthyl benzoate	----	C_6H_6	72.41	91.10	107.76	139.30	**188**
$C_{17}H_{30}O_3$	*l*-Menthyl isopropylacetoacetate	----	Nil	−48.69	−61.53	−72.91	−95.05	**188, 197**
$C_{18}H_{26}O_2$	*l*-Menthyl *o*-toluate	10	C_6H_6	−47.32	−59.74	−70.58	−91.70	
$C_{18}H_{30}O_5$	*l*-Menthyl ethyl acetylsuccinate (*α*-ester)	----	Nil	−44.76	−56.67	−67.24	−87.97	**38, 197**
			C_6H_6	−45.59	−57.80	−67.99	−89.38	
	l-Menthyl ethyl acetylsuccinate (*β*-ester)	----	Nil	−38.77	−48.80	−57.45	−74.02	**188, 197**
			C_6H_6	−40.94	−51.59	−60.68	−78.29	
$C_{18}H_{32}O_3$	*l*-Menthyl diethylacetoacetate	----	Nil	−44.35	−55.68	−65.53	−84.35	**188, 197**
			C_6H_6	−40.39	−50.77	−59.46	−76.50	
$C_{19}H_{24}O_2$	*l*-Menthyl phenylpropiolate	10	C_6H_5	−57.31	−72.56	−85.90	−111.92	**188, 197**
$C_{19}H_{26}O_2$	*l*-Menthyl cinnamate	----	C_6H_6	59.94	75.80	89.75	117.42	**188**
$C_{19}H_{26}O_3$	*l*-Menthyl benzoylacetate	10	C_6H_6	−50.95	−64.39	−76.15	−99.89	**197**
$C_{19}H_{34}O_3$	*l*-Menthyl *l*-amylacetoacetate	----	Nil	−32.40	40.48	47.66	61.01	**204**
$C_{20}H_{28}O_2$	*l*-Menthyl *α*-methylcinnamate	----	C_6H_6	49.99	62.26	72.95	92.65	**188**
$C_{20}H_{28}O_2$	*l*-Menthyl *β*-methylcinnamate	----	C_6H_6	53.13	66.35	78.01	99.61	**188**
$C_{21}H_{28}O_3$	*l*-Menthyl benzylideneacetoacetate	10	C_6H_6	−8.17	−10.97	−13.66	−21.27	**188, 197**
$C_{21}H_{30}O_3$	*l*-Menthyl *l*-benzylacetoacetate	10	C_6H_6	−94.05	−121.21	−145.67	−196.75	**188, 197**
$C_{21}H_{30}O_3$	*dl*-Menthyl *dl*-benzylacetoacetate	10	C_6H_6	−43.43	−55.10	−65.20	−85.85	**197**
$C_{22}H_{32}O_3$	*l*-Menthyl *α*-phenylethylacetoacetate	10	C_6H_6	−84.25	108.2	131.3	177.75	**204**
$C_{25}H_{30}O_3$	*l*-Menthyl *d*-benzoylphenylacetate	10	C_6H_6	13.73	21.10	28.58	49.91	**197**
	l-Menthyl *dl*-benzoylphenylacetate	10	EtOH[1]	−43.89	−58.91	−75.08	−93.57	**197**
$C_{26}H_{30}O_3$	*l*-Menthyl benzoylbenzylideneacetate	10	C_6H_6	−61.75	−78.62	−93.69	−123.84	**197**
$C_{26}H_{30}O_4$	*l*-Menthyl dibenzoylacetate	----	C_6H_6	−49.58	−64.07	−76.88	−104.18	**188, 197**
$C_{27}H_{34}O_3$	*l*-Menthyl *d*-diphenylmethylacetoacetate	10	C_6H_6	−33.83	−41.94	−48.18	−60.00	**197**
$C_{27}H_{34}O_3$	*l*-Menthyl *l*-diphenylmethylacetoacetate	10	C_6H_6	−51.13	−65.15	−78.04	−103.94	**197**
$C_{27}H_{34}O_3$	*l*-Menthyl *dl*-diphenylmethylacetoacetate	10	C_6H_6	−42.62	−53.69	−63.31	−82.43	**188, 197**
$C_{28}H_{34}O_3$	*l*-Menthyl *l*-benzoylcinnamylacetate	10	C_6H_6	−67.41	−86.08	−102.18	−135.71	**197**
$C_{28}H_{32}O_5$	*l*-Menthyl dibenzoylacetoacetate	----	C_6H_6	42.79	53.94	63.30	80.35	**188**

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[1] With one drop of piperidine.

Mutarotation of l-menthyl esters of keto-acids **(186)**

$C_{14}H_{24}O_3$ *l*-Menthyl acetoacetate

s=C_6H_6. *p*=10.02

Hours	$\left[\alpha\right]_D^{20}$
0	−64.0
1	−64.2
19	−64.5
68	−65.5
96	− 5.9

s=EtOH. *p*=9.88

Hours	$\left[\alpha\right]_D^{20}$
0	−71.4
0.75	−71.0
1.5	−70.8
2.25	−70.7
3.0	−70.2

$C_{19}H_{26}O_3$ *l*-Menthyl benzoylacetate

s=C_6H_6. *p*=10.04

Hours	$\left[\alpha\right]_D^{20}$
0	−55.4
1	−58.4
3	−61.7
5	−62.5
7	−63.2
9	−63.2
23	−63.9
50	64.0

s=EtOH. *p*=9.93

Hours	$\left[\alpha\right]_D^{20}$
0	−56.4
0.75	−56.6
3	−56.8
6	−56.9

$C_{20}H_{28}O_3$ *l*-Menthyl phenylacetoacetate

s=C_6H_6. *p*=10.04

Hours	$\left[\alpha\right]_D^{20}$
0	+28.7
80	−25.1
104	−31.3
144	−38.5
245	−49.4
319	−53.5
464	−60.7
628	−62.1
800	−64.9
1,303	−66.0
1,615	[1] −67.2

s=EtOH. *p*=10.01

Hours	$\left[\alpha\right]_D^{20}$
0	−28.3
2	−37.9
5	−49.4
9	−58.0
12	−61.5
24	−65.5
47	−67.1

$C_{25}H_{30}O_3$ *l*-Menthyl phenylbenzoylacetate

s=EtOH. *p*=1.25

Hours	$\left[\alpha\right]_D^{20}$
0	−12
2	−16
17	−39
25	−45
89	−63

$C_{20}H_{34}O_4S$ *l*-Menthyl *d*-β-camphorsulphonate $\left[\alpha\right]_\lambda^{20}$ (35)

s	c \ λ	656 μμ	589 μμ	527 μμ	486 μμ	472 μμ	457 μμ
PhMe	9.76	−12.04	−13.45	−13.95	−12.86	−12.04	--------
Me_2CO	7.54	−15.38	−17.57	−19.08	−18.73	−18.03	--------
$CHCl_3$	9.66	−17.87	−20.63	−22.92	−23.30	−22.76	−21.46

l-Menthyl *l*-β-camphorsulphonate

s	c \ λ	656 μμ	589 μμ	527 μμ	486 μμ	472 μμ	457 μμ
PhMe	9.70	−57.9	−74.7	−98.3	−122.0	−131.3	--------
Me_2CO	11.05	−57.3	−74.1	−97.8	−121.4	--------	--------

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[1] In the presence of one drop of piperidine this value is reached in eight minutes.

Mutarotation of l-menthyl esters of keto-acids (**186**)—Continued

$C_{12}H_{22}OS_2$ (40) Methyl *l*-menthylxanthate (superfused)

d=1.037

λ	$[\alpha]_{\lambda}^{20}$
657 μμ	−56.4
589	−64.8
553	−67.7
527	−67.9
517	−67.1
508	−65.7
500	−63.8
492	−61.4
486	−58.5
473	−49.1

s=PhMe. *c*=5.788

λ	$[\alpha]_{\lambda}^{20}$
673	−62.3
657	−65.1
622	−70.9
590	−76.6
560	−81.4
542	−83.9
528	−85.3
522	−85.8
517	−85.8
508	−85.6
500	−85.0
486	−82.2
473	−76.5
452	−56.7

$C_{13}H_{24}OS_2$ (40) Ethyl *l*-menthylxanthate (liquid)

d=1.020

λ	$[\alpha]_{\lambda}^{20}$
657	−52.4
589	−60.3
553	−63.0
527	−63.4
517	−62.6
508	−61.4
500	−59.8
486	−55.3
473	−47.0

s=PhMe. *c*=9.442

λ	$[\alpha]_{\lambda}^{20}$
657	−59.7
589	−70.4
553	−75.7
527	−78.6
517	−78.9
508	−78.9
500	−78.3
486	−75.5
478	−73.3
473	−70.1

$C_{18}H_{26}OS_2$ (42) Benzyl *l*-menthylxanthate

s=PhMe. *c*=9.994

λ	$[\alpha]_{\lambda}^{20}$
657	−32.0
590	−36.1
553	−36.9
528	−36.0
508	−33.8
500	−32.0
486	−28.2

$C_{22}H_{38}O_2S_3$ (33) *l*-Menthylxanthic thioanhydride

s=PhMe. *c*=5.657

λ	$[\alpha]_{\lambda}^{20}$
684	−48.5
657	−49.8
622	−49.6
603	−48.4
589	−46.5
548	−34.3
527	−21.3
516	−11.8
506	−2.2
498.5	+5.0
491	+11.8

$C_{22}H_{38}O_2S_4$ (34; *cf.*, 33) *l*-Menthyl dixanthide

s=PhMe. *c*=9.404

λ	$[\alpha]_{\lambda}^{20}$
656	−182.8
589	−225.1
527	−271.0
486	−293.3
478	−293.4
472	−292.0
466	−288.0
461	−281.9

$C_{23}H_{40}O_2S_4$ (42) Methylene di-*l*-menthylxanthate

s=PhMe. *c*=10.18

λ	$[\alpha]_{\lambda}^{20}$
683	1.37
657	3.35
622	7.66
590	13.9
553	24.8
528	37.5
508	51.6
486	75.4

$C_{13}H_{40}O_2S_4$ (42) Methylene di-*l*-menthylxanthate—Contd.

s=CS_2. *c*=7.069

λ	$[\alpha]_{\lambda}^{20}$
657	−9.70
590	−2.00
559	5.56
547	9.90
528	19.8
508	33.5
500	41.6
486	58.7

$C_{24}H_{29}NOS_2$ (39, 41) 1,2-Diphenyl-*l*-menthylimido-xanthide (*l*-Menthyl phenylthiobenzoylthiourethane, Ph.CS.N Ph. $CS.OC_{10}H_{19}$)

s=PhMe. *c*=0.138

λ	$[\alpha]_{\lambda}^{20}$
622	−192
603	−272
590	−388
582	−449
573	−536
559	−594
547	−507
536	−260
528	0
508	580
492	870
478	1,160

s=Me_2CO. *c*=0.138

λ	$[\alpha]_{\lambda}^{20}$
657	−33
622	−105
603	−185
590	−301
582	−348
573	−507
559	−579
547	−594
536	−522
528	−261

s=PhMe. *c*=0.9876

λ	$[\alpha]_{\lambda}^{20}$
687	−51
663	−80
642	−116
622	−167

Mutarotation of l-menthyl esters of keto-acids (**186**)—Continued

$C_{24}H_{29}NO_2S$ (39) *l*-Menthyl monothiourethane (*l*-menthyl phenylthiobenzoylurethane, Ph. CS. N Ph. CO. $OC_{10}H_{19}$	
s=PhMe. *c*=0.131	
λ	$[\alpha]^{20}_{\lambda}$
696	−31
657	−35
641	−39
622	−47
603	−57
590	−78
573	−110
560	−162
547	−230

$C_{24}H_{30}OS_2$ (42) Diphenylcarbinyl *l*-menthylxanthate	
s=EtOH	
657	−53.4
589	−65.3
528	−77.6
486	−82.4
478	−82.9
472	−83.3
466	−81.3

$C_{24}H_{42}O_2S_4$ (42) Ethylene di-*l*-menthylxanthate $[CH_2.S.CS.OC_{10}H_{19}]_2$	
s=PhMe. *c*=7.506	
λ	$[\alpha]^{20}_{\lambda}$
657	−56.1
622	−61.1
590	−65.4
553	−69.3
536	−70.3
528	−70.4
508	−69.3
500	−67.9
492	−66.0
486	−63.9
478	−58.0

$C_{25}H_{44}O_2S_4$ (42) Trimethylene di-*l*-menthylxanthate	
s=PhMe. *c*=6.49	
λ	$[\alpha]^{20}_{\lambda}$
675	−54.9
657	−57.2
622	−62.7
589	−67.1
553	−71.7
536	−72.7
528	−73.0
522	−73.2
517	−73.0
508	−72.6
500	−71.7
486	−68.6
478	−65.0

$C_{30}H_{34}OS_2$ (42) Triphenylcarbinyl *l*-menthylxanthate	
s=PhMe. *c*=4.395	
657	−72.8
589	−96.9
527	−127.5
486	−159.2
472	−175.0

(43) $[\alpha]^{t}_{\lambda}$

$C_{12}H_{22}OS_2$ Methyl *l*-menthylxanthate				
s=PhMe. *p*=10.18				
t \ λ	656 μμ	589 μμ	527 μμ	486 μμ
−36.6	−64.3	−75.4	−83.3	−79.3
−31.8	−64.6	−75.7	−83.6	−79.8
0.0	−65.1	−76.8	−85.1	−81.6
17.4	−65.3	−76.8	−85.3	−82.4
47.5	−65.8	−77.4	−86.0	−82.8
80.6	−66.1	−77.5	−86.2	−83.8
s=AcOEt. *p*=4.83				
−47.6	−66.6	−78.9	−87.7	−86.2
0.0	−67.7	−80.9	−90.7	−89.2
20.5	−68.4	−81.9	−91.5	−90.2
49.2	−69.3	−82.7	−93.2	−92.0

$C_{23}H_{40}O_2S_4$ Methylene di-*l*-menthylxanthate				
s=PhMe. *p*=4.89				
t \ λ	656 μμ	589 μμ	527 μμ	486 μμ
−22.0	17.4	32.4	63.7	108.8
0.0	10.8	23.4	51.4	93.3
22.0	2.8	12.0	36.6	74.3
50.4	−8.7	−2.4	16.2	47.9
80.4	−20.3	−17.5	−5.0	20.8

$C_{22}H_{38}O_2S_3$ *l*-Menthylxanthic thioanhydride				
s=PhMe. *p*=1.06				
−34.6	−22.6	1.0	+85.3	+285.
19.8	−51.3	−48.0	−20.7	+28.4
80.2	−76.0	−94.7	−127.5	--------

IIDC. THE MOLECULE CONTAINS 2 OR MORE ASYMMETRIC ATOMS ATTACHED RESPECTIVELY TO 3 OR 4 OTHER CARBON ATOMS

14. CAMPHORIC AND CAMPHOLYTIC ACIDS AND DERIVATIVES

$C_{10}H_{16}O_4$ Camphoric acid and normal camphorates (87)

Formula	Organic base (s=EtOH) $[\alpha]_D^{20}$	c=2.5	5.0
$C_{10}H_{16}O_4$	Nil	47.72	48.02
$C_{18}H_{38}N_2O_4$	*n*-Butylamine	11.16	10.96
$C_{20}H_{26}N_2O_4$	Pyridine	27.12	25.90
$C_{20}H_{38}N_2O_4$	Piperidine	14.36	14.24
$C_{22}H_{30}N_2O_4$	Aniline	31.84	32.5
$C_{24}H_{34}N_2O_4$	Benzylamine	17.16	16.92
$C_{28}H_{30}N_2O_4$	Quinoline	18.76	19.16
$C_{28}H_{38}N_2O_4$	Tetrahydroquinoline	17.28	17.56
$C_{30}H_{34}N_2O_4$	α-Naphthylamine	18.00	18.12
$C_{30}H_{34}N_2O_4$	β-Naphthylamine	18.72	18.64
$C_{30}H_{42}N_2O_4$	*ac*-Tetrahydro-β-naphthylamine	14.32	14.38
$C_{30}H_{42}N_2O_4$	*ar*-Tetrahydro-α-naphthylamine	16.76	16.92

Derivatives of camphoric acid

$C_{10}H_{14}BrNO_2$ *d*-Camphorbromoimide (52)

s	c	$[\alpha]_D^{18}$
C_6H_6	1.9412	12.0
	2.3840	11.2
	3.0828	12.0
$CHCl_3$	1.6644	13.6
	2.7372	13.0
	2.8640	12.8

$C_{10}H_{14}INO_2$ *d*-Camphoriodoimide

s	c	$[\alpha]_D^{18}$
C_6H_6	1.6220	16.0
	1.7532	16.0
$CHCl_3$	1.5408	15.2
	2.0520	15.3
	2.5792	15.7
	2.9872	15.7

$C_{11}H_{17}NO_2$ *d*-Camphormethylimide

s	c	$[\alpha]_D^{18}$
EtOH	2.4352	11.1
	3.1372	11.0
	3.5548	11.4
	4.2428	11.3
Me_2CO	2.8280	8.0
	4.1460	8.0

$C_{12}H_{19}NO_2$ *d*-Camphorethylimide

s	c	$[\alpha]_D^{18}$
EtOH	2.0864	12.4
	2.1480	12.6
	3.0352	12.5
	3.9028	12.5
Me_2CO	2.3544	8.4
	2.9392	8.8
	4.7560	8.5

$C_{17}H_{20}N_2O_4$ *d*-Camphor *p*-nitrobenzylimide

s	c	$[\alpha]_D^{18}$
Me_2CO	2.0284	11.8
	2.7180	12.3
	3.1392	12.3
C_6H_6	2.2520	2.6
	3.9712	2.8

$C_{17}H_{21}NO_2$ *d*-Camphorbenzylimide

s	c	$[\alpha]_D^{18}$
EtOH	1.8156	12.7
	2.3104	12.1
	3.2128	12.1
Me_2CO	2.8268	11.9
	2.9552	12.0
	3.3444	12.2
	3.9392	11.9
C_6H_6	2.1904	5.2
	3.8228	4.8

Derivatives of campholic and camphoric acids

Formula	Name	p	s	$[\alpha]_\lambda^{20}$				Lit.
				6,563	5,893	5,463	4,861	
$C_{10}H_{18}O$	1, 2, 2, 3-Tetramethylcyclopentane 1-aldehyde.	10	C_6H_6	68.48	89.26	108.00	148.65	**196, 198**
$C_{10}H_{18}O_2$	Campholic acid	------	C_6H_6	47.48	59.26	69.36	88.33	**188, 196**
$C_{10}H_{20}O$	1, 2, 2, 3-Tetramethylcyclopentane-1-carbinol.	------	C_6H_6	53.36	67.18	79.42	102.74	**188, 198**
$C_{11}H_{18}O_3$	1-Acetyl-1, 2, 2-trimethylcyclopentane-3-carboxylic acid.	5	C_6H_6	84.29	109.98	116.07	185.71	**196**
$C_{11}H_{20}O$	1, 2, 2, 3-Tetramethylcyclopentane-1-methyl ketone.	------	Nil	51.27	63.67	74.17	93.32	**188, 196**
			C_6H_6	53.89	--------	--------	--------	**196**
$C_{12}H_{20}O_2$	1, 2, 2, 3-Tetramethylcyclopentane-1-acrylic acid.	10	C_6H_6	52.06	66.82	79.90	107.39	**198**
$C_{12}H_{20}O_2$	Ethyl 1, 2, 2-trimethyl-3-methylenecyclopentane-1-carboxylate.	------	Nil	20.62	[1] 26.73	31.57	41.24	**195**
			C_6H_6	12.99	[1] 16.38	18.97	25.41	**195**

[1] In (**196**) these figures are quoted for the methyl ester.

Derivatives of campholic and camphoric acids—Continued

Formula	Name	p	s	$[\alpha]^{20}_{\lambda}$				Lit.
				6,563	5,893	5,463	4,861	
$C_{12}H_{20}O_3$	Methyl 1-acetyl-1, 2, 2-trimethylcyclopentane-3-carboxylate.	-----	Nil	−10. 53	−14. 02	−14. 08	−24. 99	196
		10	C_6H_6	14. 46	−19. 17	−20. 18	−33. 41	196
$C_{12}H_{22}O_2$	1, 2, 2, 3-Tetramethylcyclopentane-1-ethyl ketone.	-----	Nil	50. 64	63. 15	73. 89	94. 08	188, 196
			C_6H_6	--------	54. 83	--------	--------	196
$C_{12}H_{22}O_2$	Ethyl campholate	-----	Nil	--------	40. 49	--------	--------	196
			C_6H_6	--------	39. 79	--------	--------	196
$C_{12}H_{22}O_2$	1, 2, 2, 3-Tetramethylcylopentane-1-propionic acid.	10	C_6H_6	38. 21	48. 38	57. 20	75. 29	198
$C_{14}H_{24}O_2$	Ethyl 1, 2, 2, 3-tetramethylcyclopentane-1-acrylate.	-----	Nil	44. 91	57. 51	68. 80	91. 93	198
		10	C_6H_6	44. 47	57. 11	68. 19	91. 60	198
$C_{14}H_{26}O_2$	Ethyl 1, 2, 2, 3-tetramethylcyclopentane-1-propionate.	-----	Nil	32. 32	40. 95	48. 09	63. 15	198
		10	C_6H_6	32. 94	41. 66	49. 14	64. 54	198
$C_{16}H_{22}O$	1, 2, 2, 3-Tetramethylcyclopentane-1 phenyl ketone.	-----	Nil	5. 72	−1. 21	−12. 42	−50. 54	196
		10	C_6H_6	2. 70	−11. 47	−23. 96	−66. 49	196
		10	EtOH	21. 74	21. 68	17. 51	−3. 73	196
$C_{17}H_{24}O$	1, 2, 2, 3-Tetramethylcyclopentane-1 benzyl ketone.	-----	Nil	26. 46	32. 16	36. 40	42. 56	196
		10	C_6H_6	21. 51	25. 91	28. 05	33. 34	196
$C_{13}H_{24}O$	1, 2, 2, 3-Tetramethyl-1-cyclopentane cinnamyl ketone.	-----	----------	--------	54. 29	--------	--------	196
$C_{17}H_{24}O_2$	1, 2, 2, 3-Tetramethylcyclopentane-1-carbinyl benzoate.	10	C_6H_6	37. 75	47. 81	56. 63	73. 83	198
$C_{18}H_{26}O$	1, 2, 2, 3-Tetramethylcyclopentane-1 β-phenylethyl ketone.	-----	Nil	18. 96	23. 71	27. 68	35. 43	196
		10	C_6H_6	14. 32	18. 15	20. 86	27. 40	196
$C_{20}H_{24}O$	1, 2, 2, 3-Tetramethylcyclopentane-1 α-naphthyl ketone.	10	C_6H_6	−41. 95	−60. 52	−80. 21	−132. 25	196
		5	EtOH	−12. 23	−19. 97	−29. 45	−58. 16	196

(112)	$C_{10}H_{14}O_2$ Camphorquinone		$C_{10}H_{15}NO_2$ Isonitrosocamphor
$p=0.2$ to 0.6 $[\alpha]^{t}_{\lambda}$ t=laboratory temperature			
s / λ	=MeOH	C_6H_6	EtOH
6, 850	----------	38	----------
6, 680	----------	41	146. 9
6, 260	42. 7	48	----------
5, 940	53	60. 8	192. 6
5, 660	80	75	222
5, 430	85	100	240. 8
5, 240	122. 6	144	----------
5, 080	181	227	291. 4
5, 000	256	----------	----------
4, 930	341	368	318
4, 860	389	----------	----------
4, 800	293. 7	240	351. 7
4, 740	144	----------	----------
4, 690	102	----------	----------

Derivatives of camphorquinonehydrazoxime (*Q*) (**61**)

Formula	Name	s	c	$[\alpha]_D$
$C_{10}H_{17}N_3O$	Q (from α-isonitrosocamphor)	CHCl$_3$	1.0388	−52.4
		2 per cent NaOH		0.0
$C_{11}H_{18}N_4O_2$	Q-carbamide	CHCl$_3$	1.0576	52.8
$C_{13}H_{21}N_3O$	Isopropylidene-Q	CHCl$_3$	1.0184	−40.1
$C_{17}H_{21}N_3O$	Benzylidene-Q	CHCl$_3$	1.0164	−73.8
$C_{20}H_{32}N_4O_2$	*bis*-Isonitrosocamphanazine	CHCl$_3$	1.0336	−254.2
$C_{10}H_{17}N_3O$	Q (from β-isonitrosoepicamphor)	CHCl$_3$	1.0372	149.0
		2 per cent NaOH	1.0548	103.8
$C_{11}H_{18}N_4O_2$	Q-carbamide	2 per cent NaOH	1.0568	135.6
$C_{14}H_{21}N_3O_3$	Diacetyl-Q	CHCl$_3$	.8224	177.0
		2 per cent NaOH	.8552	87.7
$C_{17}H_{21}N_3O$	Benzylidene-Q	CHCl$_3$	1.040	94.5
$C_{17}H_{21}N_3O_2$	Benzoyl-Q	EtOH	.8420	130.5
$C_{24}H_{27}N_5O_3$	Phenylcarbaminophenylurethane-Q	CHCl$_3$	.920	137.7

15. LIMONENE

$C_{10}H_{16}$ *d*-Limonene (135; *Cf.*, 26)		$C_{10}H_{16}$ *d*-Limonene (135; *Cf.*, 26)		$C_{10}H_{16}$ *d*-Limonene (135; *Cf.*, 26)	
	$[\alpha]^t_{4,359}$		$[\alpha]^t_{5,461}$		$[\alpha]^t_{6,708}$
22.2	232.5	20.5	135.7	21.0	85.1
−.4	241.0	−.5	140.2	4.0	87.1
−22.5	249.3	−20.5	144.5	−9.0	89.2
−47.0	259.3	−40.8	148.8	−24.2	91.2
−66.0	266.2	−54.0	152.1	−41.0	93.6
				−61.0	96.5
−80.6	274.3	−67.0	155.0		
−92.0	277.8	−79.7	159.0	−82.0	100.4
−102.0	282.7	−89.7	163.0	−102.0	105.6
−115.0	289.3	−116.4	172.0	−108.0	106.5
−123.0	292.9	−124.5	176.0	−120.7	109.4
				−123.5	109.5
	$[\alpha]^t_{4,916}$		$[\alpha]^t_{5,893}$		
22.0	174.6	22.2	115.9		
−12.2	184.3	.0	120.0		
−30.4	188.4	−18.0	124.0		
−51.0	194.5	−64.0	132.1		
−74.5	201.1	−76.4	135.0		
−85.0	204.1	−89.0	137.7		
−104.0	210.7	−103.7	141.4		
−120.8	214.6	−114.0	143.2		
		−118.0	143.8		
		−123.0	145.4		
		−125.7	146.4		
		−128.0	146.3		

16. CAMPHOR AND DERIVATIVES

Specific rotation of camphor in various solvents

p	d_4^{20}	$[\alpha]_D^{20}$
$C_{10}H_{16}O$ camphor (231)		
$s=C_6H_6$		
34.91	0.9066	44.20
6.44	.8835	39.90
5.36	.8827	40.07
4.12	.8817	39.75
3.14	.8809	39.90
1.97	.8800	39.2
$s=CHCl_3$		
35.27	1.2476	45.76
5.31	1.4361	41.00
$s=CHCl_3$—continued		
4.03	1.4452	41.10
2.19	1.4586	41.23
1.15	1.4664	41.7
$s=C_2H_4Br_2$		
36.23	1.4929	56.93
3.87	2.0758	58.83
2.99	2.0983	58.93
1.86	2.1279	60.1
1.00	2.1513	60.1
$s=AcOH$		
33.26	1.0174	45.66
3.98	1.0458	42.33
3.15	1.0467	41.81
2.15	1.0478	41.3
1.13	1.0488	40.7

p (157)	$[\alpha]_D^{25}$
$C_{10}H_{16}O$ camphor	
$s=EtOH$	
0.7643	41.4
3.050	43.8
7.538	43.5
14.82	44.1
24.280	45.2
37.83	46.1
50.72	47.4
$s=Me_2CO$	
0.7962	50.1
3.054	50.6
5.037	50.2
9.992	50.6
24.27	51.2
37.83	51.9
50.73	52.5
66.94	53.3
$s=EtOAc$	
1.119	52.9
2.671	51.5
8.882	52.0
22.00	52.5
34.85	52.5
51.69	53.4
$C_{10}H_{16}O$ camphor	
$s=C_6H_6$	
0.4472	38.4
.928	38.8
2.722	40.3
4.550	41.4
9.097	42.4
22.470	43.4
35.480	45.6
52.373	47.8
$s=PhCl$	
0.7255	41.3
5.509	41.2
18.643	43.2
30.35	44.9
59.25	48.7
$s=$*iso*-BuOH	
0.9796	40.1
4.9447	43.7
23.984	46.2
46.148	48.2
56.654	48.9
$C_{10}H_{15}BrO$ (*cf.* 226) α-Bromocamphor	
$s=EtOH$	
0.5078	133.4
4.978	135.9
9.765	136.5
14.32	137.0
18.73	138.3
$s=Me_2CO$	
0.7693	138.1
7.381	143.2
22.93	144.2
34.72	145.4
48.58	146.3
$s=EtOAc$	
0.4572	139.1
4.394	141.5
20.76	142.9
31.89	144.3
38.90	144.7
$s=C_6H_6$	
0.4665	116.2
4.512	120.4
21.21	125.1
32.50	128.3
46.12	132.9

The interpolation formula for calculating the specific rotation applied to ($C_{10}H_{16}O$) camphor in various solvents (**72**)

s	Limits of p		$[\alpha]^{20}_D = A + Bp + Cp^2$
C_6H_6	11.30	54.28	$39.942+0.1627\ p$.
C_6H_6	11.07	54.20	$39.097+0.1583\ p$ (t=18.5).
MeOH	12.34	56.66	$40.979+0.03835\ p+0.0009196\ p^2$.
EtOH	12.32	56.79	$42.004+0.04968\ p+0.001006\ p^2$.
PrOH	12.19	56.37	$43.805+0.036331\ p+0.0008996\ p^2$.
HCO_2H	8.44	46.54	$19.856+0.3023\ p$.
AcOH	9.64	49.89	$41.811+0.1327\ p$.
$EtCO_2H$	10.12	50.96	$46.020+0.0938\ p$.

$C_{10}H_{16}O$ Camphor in Me_2CO (**130**)

t	d^t_4	c	$[\alpha]^t_D$	t	d^t_4	c	$[\alpha]^t_D$
13.7	0.87507	40.7410	50.549	14.3	0.81346	3.8695	49.211
13.7	.85355	27.5673	49.665	14.8	.81100	2.6196	49.511
13.7	.83880	18.6984	49.133	17.0	.80887	2.1344	49.639
13.7	.82864	12.5190	48.773	17.4	.80708	1.7758	49.695
14.3	.82166	8.4604	48.709	17.0	.80633	1.1914	49.960
14.3	.81709	5.7394	48.900	25.2	.79763	1.0684	50.070

$C_{10}H_{16}0$ Camphor (72; **cf. 9, 10, 19, 54, 55, 63, 80, 91, 109, 111, 116, 182, 206, 226, 227**)

s=C_6H_6. t=20	
p	$[\alpha]^t_D$
11.30	40.780
22.34	43.581
33.18	44.331
43.82	46.075
54.28	47.772

t=18.5	
11.07	40.786
21.87	42.548
33.28	44.387
43.70	45.950
54.20	47.638

s=MeOH. t=20	
12.34	41.592
24.14	42.495
35.46	43.495
46.26	44.738
56.66	46.104

s=EtOH. t=20	
12.32	42.769
24.10	43.930
35.57	45.020
46.25	46.248
56.79	48.070

s=PrOH. t=20° (?)	
12.19	41.381
23.90	45.145
35.10	46.188
45.93	47.397
56.37	48.711

s=CH_2O_2. t=20	
20.44	26.03
24.05	26.91
34.38	29.85
42.32	32.38
50.89	35.08
64.11	39.93

s=AcOH. t=20	
8.50	43.36
16.42	43.87
19.22	44.24
29.60	45.93
34.35	46.60
38.84	47.20
52.75	49.37

s=$EtCO_2H$. t=20	
13.60	48.34
23.06	48.98
30.60	49.70
39.08	50.53

Simple derivatives of camphor (**37**) $[\alpha]^{20}_\lambda$

Formula	Name	s	c	6,563	5,893	5,270	4,861
$C_{10}H_{16}O$	Camphor	MeOH	9.97	29.37	40.56	58.64	78.94
		CS_2	12.10	31.86	44.75	64.99	89.24
	β-Camphor (epicamphor)	MeOH	9.66	−32.84	−45.53	−66.40	−90.51
		CS_2	8.47	−45.59	−63.23	−91.57	−124.33
$C_{10}H_{14}Br_2O$	α, α-Dibromocamphor	CS_2	10.02	28.44	40.52	61.97	89.42
		C_6H_6	10.85	27.50	39.20	59.55	85.86
	α, β-Dibromocamphor	C_6H_6	9.70	61.16	80.45	109.50	140.1
$C_{10}H_{14}I_2O$	α, α-Diiodocamphor	CS_2	5.25	20.7	30.3	48.6	--------
		C_6H_6	5.02	20.7	30.5	48.6	70.8
$C_{10}H_{15}ClO$	α-Chlorocamphor	CS_2	9.36	69.7	91.8	125.2	161.0
		C_6H_6	9.24	54.20	71.10	96.40	122.30
$C_{10}H_{15}BrO$	α-Bromocamphor	CS_2	9.98	107.5	141.8	193.6	248.2
		MeOH	4.58	98.8	129.3	174.7	222.0
$C_{10}H_{15}IO$	α-Iodocamphor (cf.79)	MeOH	9.40	112.3	147.3	198.3	252.9
$C_{10}H_{18}BrNO_4S$	NH_4 α-Bromo-π-camphorsulphonate.	H_2O	5.25	63.6	85.1	117.4	152.0

Mutarotation of $C_{10}H_{15}NO_3$ nitrocamphor in various solvents
(119; cf. 19, 31, 32, 56, 118, 119, 122, 127, 168)

s	c	t	$[\alpha]_D$		Period
			Initial	Final	
C_6H_6	5	15	−124	−104	4 days.
PhMe	5	20	−106	−87	½ day.
$C_6H_4Me_2$	5	20	−99	−75	4 days.
$PhCO_2Et$	5	17	−50	−28	½ day.
CS_2	5	17	−83	−68	2 days.
$CHCl_3$	5	13	−27	−15	1 week.
Et_2O	5	18	−37	−18	2 hours.
AcOEt	5	14	−13	−2	2 hours.
Me_2CO	5	20	−7	8	¼ hour.
MeOH	5	16	−31	−12	3 hours.
EtOH	5	15	−26	−9	5 hours.
PrOH	5	17	−24	−10	2 hours.
HCO_2H	5	15	±0	12	3 hours.
AcOH	5	13	−3	8	5 hours.
$EtCO_2H$	5	14	−5	5	2 hours.

Mutarotation of $C_{10}H_{14}BrNO_3$

π-Bromonitrocamphor (119)

$s=C_6H_6$	$p=3.3$
Pseudo form	
Time	α_t
Hours	
0	(188.4)
0.5	184.0
1.0	179.7
1.5	175.0
3.5	158.2
5.0	145.2
7.0	129.5
8.7	116.0
27.0	25.7
29.0	18.7
31.7	10.7
48.6	−17.5
99.3	−38.0
Limit.	
Normal form	
0	(−51.4)
1	−50.7
25	−47.2
48	−43.7
72	−42.7
118	−40.0
144	−37.5
Limit.	
$t=13$ to 15° C.	

$C_{10}H_{16}O_4S$ *d*-Camphor-β-sulphonic acid, salts, and derivatives $s=H_2O$ (**73**)

Salts	λ / c	$[\alpha]^{20}_{\lambda}$			$[M]_D$
		5,461	5,780	5,893	
$ZnA_2.6H_2O$	2	20.75	16.84	15.83	100.7
	4	20.90	16.89	15.79	100.5
	8	20.74	16.75	15.80	100.5
$MgA_2.6H_2O$	2	22.22	17.92	16.88	100.4
	4	22.12	18.02	16.92	100.7
	8	22.20	17.92	16.82	100.1
$CdA_2.6H_2O$	2	19.37	15.72	14.74	100.7
	4	19.38	15.65	14.80	101.0
	8	19.37	15.63	14.66	100.1
	16	19.34	15.60	14.70	100.4
$CaA_2.4H_2O$	2	22.76	18.47	17.22	98.94
	4	22.67	18.32	17.15	98.50
	8	22.35	18.00	16.91	97.15
	16	22.06	17.77	16.65	95.67
$BaA_2.3H_2O$	2	20.00	16.34	15.08	98.58
	4	19.89	16.11	14.98	98.00
	8	19.57	15.77	14.77	96.64
	16	19.23	15.49	14.53	95.04
NH_2A	1	26.68	21.70	20.21	50.38
	2	26.70	21.71	20.24	50.45
	4	27.01	21.79	20.46	51.00
	8	26.99	21.81	20.46	51.00
	16	27.43	22.20	20.79	51.85
$C_5H_{11}NA$	2	20.83	17.04	15.97	50.70
	4	21.37	17.30	16.12	51.18
	8	21.63	17.56	16.50	52.38
	16	22.29	18.07		

Camphor-β-sulphonyl salts $s=CHCl_3$ (**73**: Cf. **7**)

	λ / c	5.461	5,780	5,893	[M]
$C_{10}H_{15}ClO_3S$	3.6	40.08	33.91	32.17	80.62
$C_{10}H_{15}NO_2S$	2.3	38.56	34.37	33.79	72.07
$C_{15}H_{25}NO_3S$	.57	42.58	35.91	33.45	100.15
(Piperidide)	.97	42.46	35.88	33.38	99.90
$C_5H_{11}NA$	1.6	41.40	34.94	32.37	102.8
	.92	40.54	34.06	32.08	101.9

$C_{10}H_{15}BrO_4S.3H_2O$ *d*-α-Bromocamphor-β-sulphonic acid and salts s=H_2O (175; Cf. 106, 132)

	λ / c	5, 461	5, 780	5, 893	$[M]_D$
C Acid $3H_2O$	0. 521	120. 8	103. 6	98. 3	305. 8
C	3. 130	121. 6	104. 1	99. 1	308. 2
C $BaA_2.6^1/_2H_2O$	. 391	85. 7	73. 5	69. 7	305. 0
C	1. 570	85. 2	73. 0	69. 3	303. 0
D NH_4A	. 523	88. 4	75. 0	71. 2	233. 5
D	3. 017	88. 8	75. 4	71. 5	235. 0
D	0. 5% (EtOH)	99. 7	81. 7	81. 1	266
B	. 503	53. 7	44. 8	41. 8	137. 0
C	. 498	113. 0	97. 0	91. 4	300. 0
$KA.H_2O$(?)	. 522	102. 1	87. 2	83. 4	292. 0
D	3. 180	103. 1	88. 0	84. 1	295. 0
C	. 299	109. 0	91. 9	86. 0	300. 0
D $C_2H_5NH_2A$	. 504	90. 2	77. 3	72. 9	259. 0
D	2. 561	91. 3	77. 9	73. 6	262. 0
C $AgA.1^1/_2H_2O$	. 688	85. 4	73. 0	69. 0	310. 0
C	3. 048	83. 2	71. 3	67. 7	304. 0
C $ZnA_2.5^1/_2H_2O$	. 686	94. 4	80. 2	76. 5	300. 0
D	. 581	97. 3	82. 2	77. 9	267. 0

NOTE. The salts of this acid exist in two stereoisomeric forms, one of low rotatory power and high dispersion (C) and another of high rotatory power and low dispersion (B). Both of these are converted into an equilibrium-mixture (*D*) in the presence of traces of ammonia.

$C_{10}H_{17}O_4S$ Camphor-π-sulphonic acid and its salts (87)

Formula	Organic base (s=$CHCl_3$) $[\alpha]^{20}_D$	c=2.5	5.0	$[M]^{20}_D$
$C_{10}H_{16}O_4S$	Nil	24. 04	24. 82	57. 6
$C_{14}H_{27}NO_4S.H_2O$	*n*-Butylamine	20. 44	20. 36	62. 1
$C_{15}H_{21}NO_4S$	Pyridine	31. 72	31. 42	97. 7
$C_{15}H_{27}NO_4S$	Piperidine	21. 40	22. 94	72. 7
$C_{16}H_{23}NO_4S$	Aniline	23. 32	23. 28	75. 7
$C_{17}H_{25}NO_4S$	Benzylamine	21. 36	22. 00	74. 6
$C_{19}H_{23}NO_4S$	Quinoline	26. 96	27. 90	100. 7
$C_{19}H_{27}NO_4S$	Tetrahydroquinoline	25. 36	25. 98	94. 8
$C_{20}H_{25}NO_4S$	α-Naphthylamine	20. 92	21. 38	80. 2
$C_{20}H_{25}NO_4S$	β-Naphthylamine	20. 80	21. 54	80. 8
$C_{20}H_{29}NO_4S$	*ac*-Tetrahydro-β-naphthylamine	17. 36	17. 36	65. 8
$C_{20}H_{29}NO_4S$	*ar*-Tetrahydro-α-naphthylamine	19. 80	19. 92	75. 5

$C_{11}H_{16}O_2$. Hydroxymethylenecamphor and derivatives (174)

Formula	Name	Time	s		$[\alpha]^{20}_{\lambda}$		
				$c\downarrow$ $\lambda\rightarrow$	5,893	5,750	5,461
		Hours					
$C_{11}H_{16}O_2$	*d*-Hydroxymethylenecamphor	½	EtOH*	1. 009	198	209	242
		20	EtOH†	1. 009	228	198	187
	l-Hydroxymethylenecamphor	½	EtOH*	1. 008	−195	207	239
		20	EtOH†	1. 008	−185	196	226
$C_{11}H_{15}BrO_2$	*d* - Bromohydroxymethylene-camphor	½	EtOH*	1. 188	73. 2	76. 4	85. 7
		48	EtOH†	1. 188	71. 6	74. 3	82. 9
		48	EtOH†	3. 367	73. 6	76. 4	86. 0
			C_6H_6	. 850	80. 6	83. 0	92. 4
$C_{20}H_{25}NO_2$	*l* - Hydroxyhydrindamino - *d* - methylenecamphor.	72	EtOH*†	. 497	145	157	185
		48	C_6H_6*†	. 517	99. 1	107	131
		18	AcOH*†	. 391	102	108	128
$C_{20}H_{25}NO_2$	*d* - Hydroxhydrindamino - *d* - methylenecamphor.	54	C_6H_6*†	. 512	153	164	190
		72	EtOH*†	. 518	302	335	876

NOTE.—Solutions marked with asterisk (*) exhibit mutarotation, the final value is given for each substance and marked with the dagger (†).

Divalent metallic salts of hydroxymethylenecamphor and of nitrocamphor

d-$C_{11}H_{15}O_2$=oca d-$C_{10}H_{14}NO_3$=nica (112) $[\alpha]_\lambda$

s	$CHCl_3$	$CHCl_3$	$CHCl_3$	$CHCl_3$	EtOH	$CHCl_3$	$CHCl_3$
p	----------	----------	5	5	5	5	5
Salt	Co.oca$_2$	Ni.oca$_2$	UO_2. oca$_2$	[Cu.oca$_2$(H.oca)$_2$]		Cu.oca$_2$	Co.nica$_2$
6, 840	178	----------	70	----------	----------	----------	----------
6, 650	185	140	84	----------	----------	119. 7	190
6, 450	200	----------	----------	----------	----------	147. 3	----------
6, 250	223	167	100	37. 7	87	156. 6	232
6, 100	233	----------	----------	----------	98	128. 9	----------
5, 940	247	200	122	18. 3	106	101	276
5, 780	268	----------	----------	----------	----------	----------	----------
5, 650	286	235	145	9. 4	120	55. 3	324
5, 430	333	280	175	34	140	18. 4	370
5, 240	358	322	221	56. 5	146	0	432
5, 075	412	355	267	75. 3	160	----------	456
4, 940	----------	415	320	----------	170	----------	----------
4, 800	----------	465	----------	----------	----------	----------	----------
4, 690	----------	515	----------	----------	----------	----------	----------

Tervalent metallic salts of hydroxymethylenecamphor

Salt	Cr.oca$_3$		Al.oca$_3$H.oca[1]		Salt	Cr.oca$_3$		Al.oca$_3$H.oca[1]	
s	C_6H_6	EtOH	EtOH	EtOH	s	C_6H_6	EtOH	EtOH	EtOH
p	0. 1	0. 51	0. 5–1	1	p	0. 1	0. 51	0. 5–1	1
6,840----------	--------	218. 5	475	136	5,330----------	--------	218. 5	--------	--------
6,650----------	215	256. 5	499	146	5,240----------	24	133	1, 011. 8	266
6,450----------	--------	294. 5	--------	------	5,150----------	--------	114	--------	--------
6,250----------	311	342	581	170	5,075----------	155. 5	95	1, 138. 6	292
6,100----------	--------	427. 5	--------	--------	5,000----------	--------	137. 8	--------	--------
5,940----------	622	503	675. 8	193	4,940----------	84	180	1, 271	318
5,650----------	730	589	779. 5	213	4,800----------	59. 8	204?	1, 413	345
5,540----------	--------	484	--------	--------	4,690----------	--------	--------	1, 566. 7	375
5,430----------	407	361	892. 8	240	4,580----------	--------	--------	1, 730	402

[1] See (174) and hydroxymethylenecamphor, p. 73

Dispersion data. Alkyl and alkylidene derivatives of camphor $[\alpha]_{\lambda}^{20}$

Formula	Name	s	*p* or *d*	6,563	5,893	5,461	5,270	4,861	Lit.
$C_{11}H_{17}NO$	α-Aminomethylenecamphor	EtOH	*9.98*	191.37	257.32	323.41	----------	477.19	200
	β-Aminomethylenecamphor	EtOH	*9.97*	236.57	313.76	388.23	----------	553.99	200
$C_{12}H_{18}O$	Ethylidenecamphor	Nil	.8870	154.0	203.4	----------	252.1	362.6	190
		C_6H_6	*9.99*	136.37	178.58	----------	219.31	308.49	194
$C_{13}H_{20}O$	Propylidenecamphor	Nil[1]	.9497	112.18	149.18	185.30	----------	267.40	192
		Nil[2]	.9533	55.71	73.26	89.70	----------	126.19	192
		C_6H_6	*5*	17.47	22.67	27.73	----------	37.81	192
		Nil	.9448	131.39	172.95	----------	212.96	301.48	194
		EtOH	*9.99*	130.72	171.26	----------	210.60	296.48	194
		C_6H_6	*10.05*	119.07	157.44	----------	195.25	276.96	194
$C_{14}H_{20}O_3$	Methylenecamphorpropionic acid	C_6H_6	10	24.11	32.31	40.05	----------	57.28	192
$C_{14}H_{21}NO_3$	α-Methylenecamphorethylurethane	Py	*5.26*	149.42	198.52	245.11	----------	347.35	201
	β-Methylenecamphorethylurethane	Py	*5.26*	145.93	197.17	247.62	----------	366.69	
$C_{14}H_{22}O$	*n*-Butylidenecamphor	Nil	.9389	71.61	94.58	117.13	----------	168.54	192
		Nil	.9380	124.51	161.95	----------	200.07	285.83	194
	$\Delta^{4,5}$ Pentenylidenecamphor	C_6H_6	*9.88*	112.57	149.32	----------	185.40	264.75	194
$C_{15}H_{22}O$	4-Butene-1-methylenecamphor	Nil	.9475	108.47	144.23	178.78	----------	257.48	192
$C_{15}H_{24}O$	Isoamylidenecamphor	Nil	.9275	118.67	156.69	----------	193.40	275.90	194
		C_6H_6	*9.98*	109.55	145.04	----------	179.05	254.12	194
$C_{15}H_{24}O$	*n*-Amylidenecamphor	Nil	.9332	88.94	116.48	146.18	----------	209.95	192
$C_{15}H_{26}O$	Isoamylcamphor	Nil	.9197	50.19	66.78	----------	82.57	120.17	194
		C_6H_6	*10.05*	31.29	42.34	----------	53.40	79.14	194
$C_{16}H_{26}O$	*n*-Hexylidenecamphor	Nil	.9252	106.05	141.13	175.05	----------	251.88	192
	Isohexylidenecamphor	Nil	.9202	100.85	133.84	165.68	----------	237.80	192
$C_{17}H_{20}O$	Benzylidenecamphor	C_6H_6	*10.01*	322.48	426.55	----------	530.40	741.87	194
$C_{17}H_{26}O$	Hexahydrobenzylidenecamphor	C_6H_6	*9.99*	97.64	128.13	----------	157.36	216.08	194
$C_{17}H_{26}O_3$	α-Methylenecamphor-α-isobutylacetic acid	C_6H_6	----------	82.34	108.74	133.23	----------	187.49	192
$C_{18}H_{21}NO_2$	α-Benzoylaminomethylenecamphor	Py	*5.26*	166.44	228.29	292.67	----------	453.11	200
	β-Benzoylaminomethylenecamphor	Py	*5.26*	164.28	219.29	273.15	----------	393.06	200
$C_{18}H_{22}O$	Phenylethylidenecamphor	Nil	1.0250	97.87	129	----------	159.26	226.50	194
		C_6H_6	*9.97*	87.78	115.72	----------	143.39	203.31	194
		EtOH	*9.93*	98.29	129.83	----------	160.40	227.02	194
$C_{18}H_{24}O$	Phenylethylcamphor	C_6H_6	*10.00*	16.56	22.82	----------	29.22	45.19	194
$C_{18}H_{26}O$	Phenylethylcampholketone	Nil	0.9368	40.82	51.17	59.91	----------	76.34	193
		C_6H_6	*10.0*	38.19	48.24	56.32	----------	70.41	----------
$C_{19}H_{24}O$	Phenylpropylidenecamphor	Nil	1.0104	95.81	126.92	157.35	----------	226.66	192
		Nil	1.0094	96.61	127.99	----------	157.97	225.20	194
		C_6H_6	*9.97*	89.32	117.70	----------	145.52	206.69	194
$C_{19}H_{26}O$	Phenylpropylcamphor	C_6H_6	*9.97*	39.19	52.37	----------	64.75	93.51	194
$C_{21}H_{22}O$	α-Naphthylmethylenecamphor	C_6H_6	*10.00*	263.17	353.62	----------	443.94	634.54	194

[1] *t*=20°.

[2] t=30°.

Camphor, methylcamphor, and derivatives

Formula	Name	p	s	$[\alpha]^{20}_{\lambda}$ 6,563	5,893	5,463	4,861	Lit.
$C_{10}H_{16}O$	Camphor	-------	C_6H_6	30.94	43.01	55.32	86.75	188
$C_{11}H_{18}O$	Methylcamphor	-------	C_6H_6	15.82	23.25	30.76	50.84	188
$C_{11}H_{18}O_2$	Camphorylcarbinol[1]	-------	Nil	46.31	62.11	77.67	113.48	188
			C_6H_6	16.01	23.40	31.02	50.83	*cf.* 189
$C_{12}H_{18}O_3$	Camphorylacetic acid	-------	C_6H_6	27.56	38.06	47.99	73.33	203
$C_{13}H_{20}O_2$	Camphorylacetone	-------	Nil	36.99	49.25	61.08	87.60	203
		10	C_6H_6	45.91	60.73	74.42	105.52	203 *cf.* 189
$C_{13}H_{20}O_2$	Camphorylcarbinyl acetate	-------	Nil	40.46	53.78	66.77	96.36	188
$C_{14}H_{22}O_3$	Ethyl camphorylacetate	-------	Nil	51.01	67.53	83.38	119.23	203
		10	C_6H_6	27.07	37.18	46.96	70.77	203
$C_{15}H_{26}O$	Isoamylcamphor	-------	Nil	50.19	66.78	82.57	120.17	194
			C_6H_6	31.29	42.34	53.40	79.14	*cf.* 188
$C_{17}H_{22}O$	Camphorylphenylmethane	-------	Nil	92.56	123.35	153.34	220.90	188
$C_{18}H_{24}O$	α-Camphoryl-β-phenylethane	-------	C_6H_6	16.56	22.82	29.22	45.19	194
$C_{19}H_{26}O$	α-Camphoryl-γ-phenylpropane.	-------	C_6H_6	39.19	52.37	64.75	93.51	194
$C_{20}H_{24}O_2$	Camphorylbenzylidene-3--acetone.	10	C_6H_6	35.41	47.37	58.54	83.57	203
$C_{20}H_{24}O_3$	Camphoryl-3-acetylacetophenone.	10	C_6H_6	45.38	62.52	78.31	118.59	203
$C_{21}H_{31}NO_2$	Methylenecamphor-α-aminocamphor.	2.48	C_6H_6	90.51	121.8	151.7	211.4	200
$C_{22}H_{34}O_2$	α, β-Dicamphorylethane	5	C_6H_6	44.99	60.37	75.29	110.33	188

[1] In this table "camphoryl" is used for the radical $C_{10}H_{15}O$ of camphor, and not for the radical $C_{10}H_{14}O_2$ of camphoric acid.

17. CAMPHORCARBOXYLIC ACID AND DERIVATIVES

$C_{11}H_{16}O_3$ Amine salts of camphorcarboxylic acid (rotation calculated on the concentration of the acid)

c=7.84 (133)	$\frac{M \text{ amine}}{M \text{ acid}}$		$[\alpha]^{12}_D$	
Amine	H_2O	EtOH	H^2O	EtOH
$C_{14}H_{25}NO_3$ Propylamine	1	1	90.4	81.7
	17	4.8	90.2	78.5
$C_{15}H_{27}NO_3$ Butylamine	1	1	91	81.7
	13.7	5	92.3	78.8
	--------	45	--------	73.1
$C_{15}H_{27}NO_3$ Diethylamine	1	1	92.5	82.3
	1.98	5	92.5	85
	13.7	45	92.5	85.5
$C_{17}H_{31}NO_3$ Triethylamine	1	1	92.5	82
	9.53	5	92.5	85.5
	--------	45	--------	85.5

$C_{11}H_{16}C_3$ Camphorcarboxylic acid+C_6H_7N aniline

M C_6H_7N	(c of acid=2.61)			$[\alpha]^{12}_D$ (133)			
s	EtOH	Et_2O	C_6H_6	PhMe	$C_6H_4Me_2$	Me_2CO	$PhNH_2$
0	63.2	55.8	33.2	39.6	44.3	57.7	27.4
1	62.5	55.8	33.8	39.6	44.3	57.7	--------
5	57.4	--------	--------	--------	--------	--------	--------
45	34.1	--------	--------	--------	--------	--------	--------
70	27.4	--------	--------	--------	--------	--------	--------

Influence of bases on rotatory power of $C_{11}H_{16}O_3$ camphorcarboxylic acid (**27**)

Formula	Base (s = $C_6H_4Me_2$)	c	Mols of base to 1 of acid	t_1	$[\alpha]_D^{t_1}$	t_2	$[\alpha]_D^{t_2}$
$C_{11}H_{16}O_3$	Nil	0.18	----------	32	44.2	57	46.2
		.18	----------	22	42.1	50	45.2
$C_{16}H_{21}NO_3$	Pyridine	.5	1.2	23	34.5	48	39.2
		.5	10.4	----------	----------	49	33.0
$C_{16}H_{27}NO_3$	Piperidine	.13	1.4	25	61.7	47	60.0
		.13	3.0	25	61.7	48	60.0
$C_{16}H_{29}NO_3$	Isoamylamine	.12	1.0	19	65.3	48	63
		.12	2.0	22	65.7	48	63
$C_{17}H_{23}NO_3$	α-Picoline	.74	1.0	22	33.3	49	38.7
		.74	5.1	27	30.3	48	34.2
$C_{18}H_{25}NO_3$	Benzylamine	.02	1.5	22	49.2	48	49.2
		.02	3.0	30	49.4	48	49.6
$C_{18}H_{25}NO_3$	*m*-Toluidine	.20	1.9	18	42.5	48	45
$C_{19}H_{27}NO_3$	Collidine	.39	1.02	21	36	48	40
		.39	4.5	22	31.8	48	35.8
$C_{19}H_{27}NO_3$	Dimethylaniline	.39	5.5	19	32.5	48	36.2
		.28	1.2	19	41.2	48	44.5
$C_{19}H_{35}NO_3$	Diisobutylamine	.18	1.04	22	65.7	48	62.8
		.17	2.15	25	67.2	47	64.7
$C_{20}H_{23}NO_3$	Quinoline	.84	1.3	22	36.3	48.5	40.3
		.84	4.1	21	29.2	48	36.7
		.84	7.3	22	27.5	49	33.7
$C_{20}H_{37}NO_3$	Tripropylamine	.13	1.0	22	40.3	48	41.8
		.13	1.5			48	
$C_{21}H_{25}NO_3$	Quinaldine	1.4	1.7	17.5	30	48	38.3
		1.4	4.1	24	25.4	48	33.0
		1.4	5.7	22	23	49	31.7
$C_{22}H_{33}NO_3$	Diethylbenzylamine	.32	1.02	19	37.5	47	40.8
		.41	2.0	26	36.7	48	40.0
$C_{22}H_{43}NO_3$	Triisobutylamine	.17	1.3	20	43.0	48	45

Dispersion data, camphorcarboxylic acid derivatives

Formula	Name	s	c \ λ	6,708	6,438	5,893	5,461	5,086
$C_{11}H_{16}BrNO_2$	α, α′-Bromocamphorcarboxamide.	EtOH	5	29.4	--------	38.4	45.8	--------
$C_{16}H_{24}BrNO_2$	α, α′-Bromocamphorpiperidide.	EtOH	------	−54.5	−58.5	−71.2	−86	−102.3

Formula	Name	s	c \ λ	4,800	4,678	4,359	Lit.
$C_{11}H_{16}BrNO_2$	α, α′-Bromocamphorcarboxamide	EtOH	5	--------	--------	82.6	--------
$C_{16}H_{24}BrNO_2$	α, α′-Bromocamphorpiperidide	EtOH	------	−118.0	−126.0	−150.9	79

Derivatives of camphorcarboxylic acid c=5 (**125**)

Time	$[\alpha]_{5,461}$
$C_{11}H_{17}NO_2$ Mutarotation of camphorcarboxamide	
$s=EtOH$	
Hours	
0.1	−0.2
.2	.1
.3	.2
.4	.3
.5	.4
.6	.6
.8	1.1
1.0	1.4
1.5	2.5
2.0	3.7
2.5	4.8
3.0	5.9
3.5	7.1
4.0	8.2
4.5	9.4
5.0	10.4
8.0	17.2
9.0	19.0
10.0	21.0
11.0	23.3
12.4	25.8
14.2	29.3
22.0	43.4
26.0	50.3
30.0	56.4
33.0	60.7
34.0	62.3
36.0	64.8
48.0	81.1
50.0	84.0
51.0	85.4
52.0	86.5
53.0	88.3
54.5	90.3
56.0	91.8
58.0	93.8
59.4	94.7
61.0	96.0
71.0	99.6
83.0	100.4
Final	100.8

Time	$[\alpha]_{5,461}$
$C_{11}H_{17}NO_2$ Mutarotation of camphorcarboxamide	
$s=C_6H_6$	
Hours	
0.1	1.5
.2	2.0
.4	2.9
.6	3.6
.8	4.7
1.0	5.5
2.0	10.1
3.0	15.0
4.0	19.9
5.0	24.1
6.0	28.7
7.0	32.6
8.0	36.5
10.0	43.4
12.0	49.2
13.3	52.4
23.0	67.4
25.0	68.0
28.4	69.7
31.0	71.0
36.0	70.9
48.0	72.7
61.0	73.8
96.0	74.4

Time	$[\alpha]_{5,461}$
$C_{16}H_{25}NO_2$ Mutarotation of camphorcarboxypiperidide	
$s=C_6H_6$	
Hours	
0.1	25.8
.4	25.5
2.0	25.5
9.0	25.3
12.0	25.6
24.0	27.7
30.0	28.7
36.0	29.9
48.0	32.9
54.0	34.2
61.0	36.2
72.0	39.1
78.0	40.6
84.0	42.2
96.0	44.2
108.0	46.5
132.0	49.8
Days	
6.0	51.2
6.5	51.2
7.0	52.9
7.5	54.3
8.0	54.7
8.5	54.8
9.0	54.8
10.0	55.6
15.0	56.3
21.0	56.9
40.0	56.7

Time	$[\alpha]_{5,461}$
$C_{16}H_{25}NO_2$ Mutarotation of camphorcarboxypiperidide	
$s=C_6H_6$	
Hours	
0.5	24.7
.7	24.7
1.0	24.7
1.5	24.7
2.0	25.0
2.3	25.3
2.5	25.3
3.0	25.4
3.5	25.6
4.0	25.8
4.5	25.7
5.0	25.6
5.5	25.6
6.5	25.8
8.0	26.3
9.0	26.5
10.0	26.6
11.0	27.0
12.0	27.1
13.0	27.5
22.0	28.0
28.0	29.0
30.0	29.2
33.1	29.6
36.0	30.0
46.8	30.9
54.0	31.3
59.0	31.6
70.0	32.4
73.0	32.6
78.0	33.3
84.0	33.7
94.0	34.4
102.0	35.4

18. BORNEOL AND RELATED COMPOUNDS

Borneol and isoborneol (**104**)

Formula	Name	s	c	$[\alpha]_{5,893}$	$[\alpha]_{5,780}$	$[\alpha]_{5,461}$	$[\alpha]_{4,358}$
$C_{10}H_{18}O$	*l*-Borneol	EtOH	5.51	36.79	39.10	44.54	76.05
	d-Isoborneol	EtOH	5.16	33.89	35.38	39.61	65.31
		$CHCl_3$	4.99	20.33	20.92	23.33	37.05
$C_{18}H_{22}O_4$	*d*-Bornyl hydrogen phthalate	C_6H_6	4.78	42.72	45.02	51.93	91.70
		CS_2	1.65	46.06	47.28	51.82	96.96
		EtOH	5.18	56.72	59.71	68.39	123.60
	l-Isobornyl hydrogen phthalate	$CHCl_3$	5.33	77.47	80.74	92.76	163.34
		EtOH	5.19	81.62	85.27	97.97	173.71

Specific rotation $[a]^t_\lambda$ *of* $C_{12}H_{20}O_2$ *l-bornyl acetate at different temperatures* (**104**)

$\overset{t}{\downarrow}$ λ→	5,893	5,780	5,461	4,358
20	−42.43	−44.16	−50.18	−84.33
40	−40.75	−42.49	−48.19	−80.98
60	−39.06	−40.71	−46.18	−77.49
80	−37.64	−39.22	−44.52	−74.56
100	−36.44	−38.08	−43.16	−72.40
120	−35.22	−36.84	−41.80	−70.04
140	−34.00	−35.58	−40.46	−67.79
160	−33.04	−34.47	−39.09	−65.55
180	−32.30	−33.55	−37.67	−63.43

$[\alpha]^{20}_{\gamma}$ (**174**; *cf.* **57, 58, 59, 60**)

Formula	Name	s	$\overset{c}{\downarrow}$ λ→	5,893	5,780	5,461
$C_{10}H_{20}BrN$	*d*-Bornylamine hydrobromide	H_2O	2.465	17.6	18.5	20.7
		H_2O	1.023	17.6	18.6	20.8
		EtOH	4.931	18.9	19.8	22.3
		EtOH	1.644	18.6	19.5	21.9
		$CHCl_3$	.673	26.0	26.8	32.0
$C_{17}H_{23}NO$	Benzoyl-*d*-bornylamine	EtOH	4.027	−21.6	−22.7	−26.3
		EtOH	1.005	−20.6	−22.1	−25.6
$C_{10}H_{19}N$	*d*-Neobornylamine [1]	EtOH	4.413	−38.0	−39.5	−44.4
	d-Neobornylamine [2]	EtOH	4.0	−43.7		
$C_{10}H_{20}BrN$	*d*-Neobornylamine hydrobromide [1]	H_2O	2.470	−31.4	32.5	37.0
		H_2O	1.001	−31.2	32.7	37.0
		EtOH	1.637	−33.0	34.5	39.4
		$CHCl_3$	0.671	−37.3	39.9	44.4
$C_{17}H_{23}NO$	Benzoyl-*d*-neobornylamine [2]	EtOH	1.8	−44.7		

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[1] Probably not quite pure.

[2] These values were determined by Forster, and probably refer to the pure substance.

Derivatives of borneol

λ	$[\alpha]_\lambda^t$
$C_{12}H_{20}OS_2$ (39) Methyl *d*-bornylxanthate	
s=PhMe. c=5.95	
675 μμ	31.4
657	32.7
622	35.5
589	37.7
559	39.8
542	40.5
527	40.5
508	39.5
500	38.5
486	35.6
472	30.7
451	15.3
$C_{13}H_{22}OS_2$ (39) Ethyl *d*-bornylxanthate	
s=PhMe. c=5.881	
657	28.8
621	31.6
589	33.4
548	35.1
537	35.4
527	34.9
516	34.5
506	33.5
498	32.6
486	28.9
$C_{22}H_{34}O_2S$ (33, 39, 40) *l*-Bornyldixanthide [S.CS.OBor]$_2$ (superfused)	
657	−49.8
589	−58.9
553	−63.2
527	−65.3
517	−65.3
508	−65.0
500	−64.3
486	−61.0
472	−54.5
s=PHMe. c=4.154	
657	−36.6
589	−42.4
548	−44.1
527	−43.8
498	−39.0
485	−33.7
478	−29.6
466	−19.5
451	2.7
446	11.3

λ	$[\alpha]_\lambda^t$
$C_{22}H_{34}O_2S$ (33, 39, 40) *l*-Bornyldixanthide [S.CS.OBor]$_2$ (superfused)	
c=10.47	
656	−37.3
589	−43.0
553	−44.8
527	−44.6
517	−43.5
508	−42.1
486	−35.0
466	−20.5
451	1.3
$C_{23}H_{36}O_2S_4$ (42) Methylene *l*-bornylxanthate CH_2(S.CS.OBor)$_2$	
s=PhMe. c=5.23	
685	−1.1
675	−.8
657	.4
622	3.1
590	5.9
553	12,0
528	18.9
500	31.7
486	39.8
$C_{24}H_{27}NOS_2$ (41) 1, 2-Diphenyl-*d*-bornyl imidoxanthide Ph.CS.NPh. CS.OBor.	
s=PhMe. c=0.1468	
622	242
603	340
590	399
582	405
578	408
559	327
547	129
536	−82
528	−279
492	−1,290
478	−1,500
s=Me_2CO. c=0.1456	
603	309
578	385
573	412
559	412
547	275
536	164

λ	$[\alpha]_\lambda^t$
$C_{25}H_{29}NOS_2$ (41) 1-Phenyl-2-*o*-tolyl-3-*d*-bornylimidoxanthide Ph.-CS.N(C_7H_7).CS.OBor	
s=PhMe. c=0.1390	
657	119
622	255
590	417
573	417
559	331
547	158
s=Me_2CO. c=0.1424	
657	77
622	190
590	337
573	351
559	323
547	182
$C_{25}H_{29}OS_2$ (41) *l*-Phenyl-2-*p*-tolyl-3-*d*-bornylimidoxanthide Ph. CS.N(C_7H_7).CS.OBor	
s=PhMe. c=0.1390	
657	173
603	425
590	489
582	504
578	489
573	474
559	417
s=Me_2CO. c=0.1424	
657	140
590	380
578	420
573	450
559	435
553	365
547	310
$C_{30}H_{32}OS_2$ (42) Triphenylmethyl *l*-bornylxanthate CPh_3.S.CS.OBor	
s=EtOH	
657	−25.5
589	−34.3
553	−40.6
528	−46.4
508	−52.6
500	−56.2
486	−64.0

Influence of temperature on dispersion of methyl l-bornylxanthate

$C_{12}H_{20}OS_2$ (43) $[\alpha]_{\lambda}^{t}$				
s=PhMe. $p=10.04$				
t \ λ	656 $\mu\mu$	589	527	586
−36.6	−39.6	−46.7	−51.3	−47.8
−31.8	−39.3	−46.0	−50.0	−46.7
0	−35.5	−41.1	−44.4	−40.2
+20	−32.9	−38.1	−40.7	−35.6
+46.4	−30.2	−34.8	−36.1	−30.5
+80.2	−26.4	−30.4	−30.2	−23.6
s=AcOEt $p=4.86$				
−49.5	−48.5	−57.7	−65.7	−67.2
0	−39.2	−46.0	−51.1	−50.4
20.5	−36.3	−42.2	−45.8	−43.1
50.2	−31.2	−36.4	−38.7	−34.7

19. FENCHYL ALCOHOL DERIVATIVES

Derivatives of fenchyl alcohol

$C_{22}H_{34}O_2S_3$ (41) Fenchylxanthic thioanhydride $[\alpha]_{\lambda}^{t}$				
s=PhMe. $p=2.09$. (43)				
λ \ t	0	22.4	50.9	81.5
674	36.2	35.4	35.4	33.8
656	35.7	33.8	34.5	33.8
589	26.0	24.4	24.6	23.7
527	33.5	34.9	35.4	39.1
508	89.8	--------	93.7	[1] 94.1(?)

[1] The query is in the original paper.

Derivatives of fenchyl alcohol—Continued

s=PhMe.	$[\alpha]_\lambda$ c=6.004
687	−36.0
670	−36.0
657	−36.1
641	−35.2
631	−34.3
622	−33.3
612	−31.6
600	−29.2
589	−25.6
570	−18.1
559	−9.6
547	1.9
536	16.7
527	34.1
s=Me₂CO.	c=5.95
701	−52.6
682	−55.2
656	−57.3
631	−57.9
612	−57.2
588	−53.8
553	−38.0
527	−6.3
517	42.3
508	57.8
504	73.9
496	87.3
$C_{22}H_{34}O_2S_4$ (42) Fenchyl dixanthide $[.S.CS.OFen]_2$	
s=PhMe.	c=4.35
657	74.2
589	98.9
527	136.3
486	181.4
479	191.5
473	203.7
467	215.6
462	227.6
457	240.2

$C_{23}H_{36}O_2S_4$ (42) Methylene fenchylxanthate, $CH_2(S.CS.O.Fen)_2$	
s=PhMe.	c=7.77
657	−40.8
590	−51.2
553	−57.8
528	−63.0
500	−68.0
486	−70.3
478	−70.5
$C_{24}H_{27}NOS_2$ (39, 41) 1,2-Diphenylfenchylimidoxanthide, Ph.CS.NPh.CS.OFen	
s=PhMe.	c=1.416
696	75
687	109
663	225
642	338
634	436
s=PhMe.	c=0.1304
622	630
603	900
590	1,050
582	1,040
578	1,000
573	930
566	770
559	560
553	290
547	15
542	−315
536	−640
528	−1,590
508	−2,440
500	−2,940
492	−3,160
486	−3,340
478	−3,530

$C_{24}H_{27}NOS_2$ (39, 41) 1,2-Diphenylfenchylimidoxanthide, Ph.CS.NPh.CS.OFen	
s=Me₂CO.	c=0.1302
657	150
622	430
603	630
590	799
582	829
578	876
573	814
566	783
559	630
553	461
547	246
528	−829

20. TERESANTALIC AND ISOTERESANTALIC ACIDS

Dispersion data. Other acids derived from camphor (**202**)

Formula	Name	$[\alpha]^{20}_\lambda$					
		s	*p* or *d*	6,563	5,893	5,463	4,861
$C_{11}H_{18}O_2$	Methyl teresantalate	Nil	1.0305	−48.19	−60.79	−71.79	−93.04
		C_6H_6	*10.0*	−50.43	−63.57	−75.36	−97.82
	Methyl isoteresantalate	Nil	1.0269	−84.51	−108.75	−130.34	−174.31
$C_{10}H_{14}O_2$	Teresantalic acid	C_6H_6	*10.0*	−60.84	−76.60	−91.70	−117.76
	Isoteresantalic acid	C_6H_6	*10.0*	−99.29	−127.58	−152.41	−204.52
$C_{11}H_{17}ClO_2$	Methyl hydrochloroteresantalate	C_6H_6	*10.0*	7.22	9.22	10.45	14.33

V. Class III. COMPOUNDS CONTAINING NO ASYMMETRIC CARBON ATOM, OR CONTAINING AN ASYMMETRIC OR DISSYMMETRIC ATOM OF SOME OTHER ELEMENT

(a) COMPOUNDS CONTAINING ASYMMETRIC ATOMS OF S, P, ETC.

21. METHYLETHYLPHENACYLTHETINE DERIVATIVES

(a) Compounds containing asymmetric atoms of S, P, etc.

Salts of methylethylphenacylthetine, $C_{11}H_{16}O_3S$ (=MOH)

(215)		$[a]_{\lambda}^{20}$		
s	c ↓ λ→	4,359	5,781	5,893
$C_{21}H_{29}BrO_6S_2$ *d*-M *d*-α-bromocamphor-π-sulphonate				
H_2O	0.603	72.5	61.3	59.7
	.610	70.9	61.1	59.0
	.945	71.4	60.8	59.2
EtOH	.807	83.9	70.6	67.2
	1.034	83.6	70.8	66.2
$C_{21}H_{29}BrO_6S_2$ *l*-M *d*-α-bromocamphor-π-sulphonate				
H_2O	0.260	56.9	48.3	46.3
	.484	56.2	47.4	46.4
	.760	57.2	48.0	46.0
	1.190	57.6	47.5	46.9
EtOH	.192	72.9	61.2	57.3
	.320	71.1	60.9	56.2
	.387	71.8	60.8	56.9
$C_{17}H_{17}N_3O_8S$ *d*-M picrate				
Me_2CO	0.575	15.7	13.5	12.2
	.713	15.8	13.7	11.9
	1.464	15.9	13.6	12.2
$C_{17}H_{17}N_3O_8S$ *l*-M picrate				
Me_2CO	0.480	−16.7	−14.1	−13.0
	.948	−15.8	−14.0	−12.4
	2.289	−16.2	−13.8	−12.6
$C_{17}H_{17}N_3O_9S$ *d*-M styphnate				
Me_2CO	0.625	11.6	10.0	9.2
	.908	11.6	10.2	9.1
$C_{17}H_{17}N_3O_9S$ *l*-M styphnate				
Me_2CO	0.684	−12.1	−10.6	−9.9
	1.009	−12.3	−10.7	−10.0

22. BROMOCAMPHOR- AND CAMPHORSULPHONATES PHOSPHONIUM SALTS

s=H_2O (169)			$[a]_{\lambda}^{15}$		
(a)	*d*-α-Bromocamphor-π-sulphonates	c ↓ λ→	4,359	5,781	5,893
$C_{10}H_{18}BrNO_4S$	Ammonium salt	0.488	104.0	87.9	84.0
$C_{31}H_{36}BrO_4PS$	*dl*-Phenyl-*p*-tolylbenzylmethylphosphonium salt	.836	53.9	45.85	43.74
(b)	*d*-Camphor-β-sulphonates				
$C_{10}H_{19}NO_4S$	Ammonium salt	.498	26.6	21.6	20.1
$C_{31}H_{37}O_4PS$	*dl*-Phenyl-*p*-tolylbenzylmethylphosphonium salt	1.058	12.3	9.9	9.2

(*b*) COMPOUNDS CONTAINING DISSYMMETRIC METALLIC ATOMS (Co, Cr, Rh, Ir, Pt, Etc.)

en=ethylenediamine, $H_2N.\ CH_2.\ CH_2.\ NH_2$.
pn=propylenediamine, $H_2N.\ CH(CH_3)CH_2.\ NH_2$.
tr=trimethylenediamine $H_2N.\ CH_2.\ CH_2.\ CH_2.\ NH_2$.

23. COBALT COMPLEXES

Trialkylenediamminecobaltic salts

I=$[Co.\ pn_3]Br_3.\ 2H_2O$. II=$[Co.\ en_3]Br_3.\ 2H_2O$

s=H_2O p=0.1 (212) $[M]_\lambda$ [1]

λ	I (*d*-pn)	I (*l*-pn)	II (*d*-salt)	II (*l*-salt)
6, 615	−175	+173	0 (?)	0 (?)
6, 435	−120	+122	+82	−82
6, 260	0	0	+232	−227
6, 075	+111	−111	+376	−374
5, 893	+223	−223	+603	−603
5, 740	+459	−457	+868	−863
5, 600	+836	−824	+1, 257	−1, 250
5, 475	+1, 379	−1, 370	+1, 841	−1, 830
5, 270	+2, 508	−2, 479	+3, 100	−3, 095
5, 075	+1, 114	−1, 114	+2, 477	−2, 477
5, 035	0	0	------------	------------
4, 990	−1, 114	+1, 114	+1, 452	−1, 452
4, 920	------------	------------	0	0
4, 850	------------	------------	−937	+927

[1] The largest value of α was 1.2°; the last figure in each number is therefore uncertain.

(94)

s=H_2O. p=60

λ	$[M]^{15}_\lambda$	λ	$[M]^{15}_\lambda$	λ	$[M[^{15}_\lambda$
6, 750	165	6, 265	394	5, 760	828
6, 600	228	6, 100	513	5, 595	[2] 1, 069
6, 425	306	5, 910	638		

[2] p=1.91.

(95)

λ	$[M]_\lambda$
s=H_2O. *p*=0.5 to 7.3	
6, 750	[1] ±165
6, 600	±216
6, 425	±290
6, 265	±375
6, 100	±448
5, 910	±599
5, 760	±790
5, 595	±931
5, 420	±1, 399
5, 260	±1, 903
5, 085	±2, 377
4, 920	±2, 705
[Co. en$_3$](ClO$_4$)$_3$	
s=H_2O. *c*=0.57	
5, 085	±2, 592
5, 260	±1, 804
5, 420	±1, 407
5, 595	±999
5, 760	±743
5, 910	±513
6, 100	±444
6, 265	±407
6, 425	±327
6, 600	±212

λ	$[M]_\lambda$
Co. en$_3$(CNS)$_3$	
s=H_2O *d*-salt, *c*=0.68 *l*-salt, *c*=0.81	
5, 420	±133
5, 595	±781
5, 760	±616
5, 910	±491
6, 100	±401
6, 265	±267
6, 425	±179
[Co. en$_3$]I$_3$ H_2O	
s=H_2O *d*-salt, *c*=0.59 *l*-salt, *c*=0.55	
5, 085	±2, 158
5, 260	±1, 843
5, 420	±1, 435
5, 595	±1, 072
5, 760	±774
5, 910	±599
6, 100	±470
6, 265	±357
6, 425	±274
6, 600	±211

λ	$[M]_\lambda$
[Co(C_2O_4)$_3$]K$_3$, 3½H_2O	
s=H_2O. *c*=0.41	
4, 740	±389
4, 780	±402
4, 870	±418
4, 945	±441
5, 020	±465
5, 105	±492
5, 180	±511
5, 260	±552
5, 340	±596
5, 420	±640
5, 515	±705
5, 610	±786
5, 700	±869
5, 800	±974
5, 910	±1, 135
6, 020	±1, 266
6, 140	±839
6, 260	∓18
6, 380	∓543
6, 520	∓422
6, 660	∓174
6, 800	∓34
6, 940	∓19

[1] Mean values for *d*- and *l*-salts.

(209, 224)

d- and *l*- [$C_5H_7O_2$.Co.en$_2$] X $[M]_D$[1]

Acetylacetonatodiethylenediamine salts

s=H_2O. *c*=0.1 $[M]_D$

X	*d*-	*l*-
Cl_2	+2, 107	−2, 134
Br_2	+2, 102	−2, 102
I_2	+2, 204	−2, 204
$(ClO_4)_2$	+2, 107	−2, 107
$(NO_3)_2$	+2, 217	−2, 217
$(SCN)_2$	+2, 107	−2, 107
S_2O_8	+2, 040	−2, 261

d- and *l*- [$C_6H_9O_2$.Co.en$_2$] X

Propionylacetonatodiethylenediamine salts

s=H_2O. *c*=0.1

X	*d*-	*l*-
$(ClO_4)_2$	+2, 476	−2, 436
$(NO_3)_2$	+2, 481	−2, 460
S_2O_8	+2, 311	−2, 383

[1] The last figures in these numbers are uncertain.

d- and *l*-$[C_6H_9O_2.Co.en_2]\ I_2$ Propionylacetonatodiethylenediaminecobaltic iodide		
s=H_2O. *c*=0.1		
λ	$[\alpha]_\lambda$	
	d-	*l*-
6, 440	+115	−135
6, 260	186	−190
6, 075	276	−268
5, 893	402	−390
5, 750	518	−535
5, 600	630	−645

d- and *l*-$[C_6H_9O_2.Co.en_2]\ I_2$ Propionylacetonatodiethylenediaminecobaltic iodide		
s=H_2O. *c*=0.1		
λ	$[\alpha]_\lambda$	
	d-	*l*-
5. 540	650	−672
5, 475	600	−628
5, 425	554	−584
5, 370	440	−480
5, 320	360	−388

24. CHROMIUM COMPLEXES

$[Cr(C_2O_4)_3.]\ K_3.3H_2O$ (95)	
s=H_2O	
λ	$[M]_\lambda$
4, 600	−1, 550
4, 800	−1, 710
5, 000	−2, 100
5, 200	−2, 300
5, 300	−2, 200

$[Cr(C_2O_4)_3]\ K_3.3H_2O$ (95)	
s=H_2O	
λ	$[M]_\lambda$
5, 400	−2, 100
5, 500	−1, 400
5, 600	−900
5, 700	0
5, 800	+1, 750

$[Cr(C_2O_4)_3]\ K_3.3H_2O$ (95)	
s=H_2O	
λ	$[M]_\lambda$
5, 950	1, 960
6, 200	600
6, 340	0
6, 400	−100
6, 500	−200

d- and *l*-$[Cr.en_3]\ I_3.\ H_2O$	
(95; *cf.*, 96)	
Values for *d*-salts are +, for l-salts −	
s=H_2O *p*=1.01–0.03 *t*=15°–18°	
4, 260	2, 826
4, 420	2, 538
4, 640	2, 205
4, 860	1, 761
5, 100	1, 171

d- and *l*-$[Cr.en_3]\ I_3.\ H_2O$	
(95; *cf.*, 96)	
Values for *d*-salts are +, for l-salts −	
s=H_2O *p*=1.01–0.03 *t*=15°–18°	
5, 260	965
5, 430	763
5, 610	574
5, 800	409

d- and *l*-$[Cr.en_3]\ I_3.H_2O$	
(95; *cf.*, 96)	
Values for *d*-salts are +, for l-salts −	
s=H_2O *p*=1.01–0.03 *t*=15°–18°	
6, 020	291
6, 260	233
6, 520	195
6, 660	182

25. RHODIUM COMPLEXES

λ	$[M]_\lambda$
d- and *l*- Rhodiumtriethylenediamines	
$[Rh.en_3]Br_3.2H_2O$ (95)	
s=H_2O. p=7.31	
6, 780	−244
6, 640	−251
6, 520	−260
6, 380	−278
6, 260	−296
6, 140	−309
6, 030	−328
5, 890	−346
5, 700	−372
5, 510	−400
5, 340	−425
5, 180	−446
5, 100	−458
4, 860	−481
4, 710	−495
4, 310	−508
4, 150	−509
$[Rh.en_3]I_3.H_2O$ (95)	
s=H_2O. p=4.53	
6, 840	±205
6, 660	218
6, 520	232
6, 380	247
6, 260	255
6, 140	273
6, 030	293
5, 890	302
5, 800	312
5, 700	326
5, 605	335
5, 510	347
5, 420	359
5, 340	366
5, 260	380
5, 180	387
5, 100	396
5, 020	405
4, 945	411
4, 860	420
4, 780	428
4, 710	434
4, 650	442
4, 560	447
4, 480	450
4, 420	454
4, 310	455
4, 260	456
4, 150	457
4, 060	458
4, 010	459
3, 940	460
3, 880	402
3, 820	366
3, 780	340
3, 740	323
3, 700	322
d- and *l*- Rhodiumtriethylenediamines	
$[Rh.en_3](NO_3)_3$ (95)	
s=H_2O. p=3.37	
6, 840	−240
6, 660	260
6, 520	265
6, 380	284
6, 260	298
6, 140	319
6, 063	334
5, 890	300
5, 800	370
5, 700	386
5, 605	402
5, 510	420
5, 420	430
5. 340	440
5, 260	456
5, 180	463
5, 100	472
4, 945	495
4, 780	518
4, 650	536
4, 480	550
4, 310	562
$[Rh(C_2O_4)_3]K_3.H_2O$ (95)	
s=H_2O. p=10.96–0.5	
4, 860	1, 724
4, 950	1, 419
5, 020	1, 225
5, 100	997
5, 180	833
5, 260	686
5, 340	553
5, 420	411
5, 510	325
5, 605	225
5, 700	146
5, 800	79
5, 890	30
5, 900	25
5, 970	0
6, 030	−22
6, 140	−56
6, 260	−82
6, 380	−102
6, 520	−114
6, 660	−121
6, 800	−126
6, 946	−133
d- and *l*- Rhodiumtriethylenediamines	
$[Rh(C_3H_2O_4)_3]K_3.1\frac{1}{2}H_2O$ Malonate (95)	
s=H_2O. p=0,804 and 1.503	
5, 340	±261
5, 420	[1] ±263
5, 515	±267
5, 610	[1] ±276
5, 700	±280
5, 800	[1] ±284
5, 910	±271
6, 020	[1] ±258
6, 140	±250
6, 260	[1] ±246
6, 380	±241
6, 520	[1] ±236

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[1] p=0.511.

26. IRIDIUM COMPLEXES

d-Triethylenediamine salts (**225**)

d-[Ir.en$_3$]X$_3$ $[\alpha]_\lambda$

X	p ↓ λ→	6,563	5,893	5,270
I	0.25	30	42	56
NO_3	.25	41.2	57.2	75.2
ClO_4	.2	34.5	48.5	64.0

d-Dinitritodiethylenediamine salts

$[Ir(NO_2)_2en_2]X$ (225)

s=H_2O	$p=0.25$	$[\alpha]_\lambda$	
X ↓ λ→	6,563	5,893	5,270
Br	17.2	26.0	40.0
ClO_4	16.4	24.8	38.4
NO_3	18.0	27.2	41.2

27. PLATINUM COMPLEXES

Platinum complexes containing d- and l-propylenediamine (**212**)

s=H_2O $c=0.5$	$[M]_{6,563}$	$[M]_{5,893}$	$[M]_{5,270}$
l-[Pt. d-pn$_3$]Cl$_4$.H$_2$O	−844	−1,013	−1,419
d-[Pt. l-pn$_3$]Cl$_4$.H$_2$O	+839	+1,035	+1,413
l-[Pt. d-pn$_3$]Br$_4$	−833	−1,024	−1,422
d-[Pt. l-pn$_3$]Br$_4$	+840	+1,031	+1,429
l-[Pt. d-pn$_3$]I$_4$	−851	−1,054	−1,433
d-[Pt. l-pn$_3$]I$_4$	+832	+1,036	+1,424

Complex metallic salts containing l-propylenediamine (**44**)

s=H_2O	p	$[M]_D$
[Pt. pn$_2$]Cl$_2$	16.6	+192
[Pt. pn. 2NH$_3$]Cl$_2$	17.5	+94
[Pt. en. pn]Cl$_2$	19.1	+96
[Pt. pn. tr]Cl$_2$	13.1	+98
[Pd. pn$_2$]Cl$_2$	17.7	+258
[Ni. pn$_3$]Cl$_2$.H$_2$O	11.0	+55

28. MOLYBDENYL AND TUNGSTYL DERIVATIVES OF MALIC AND TARTARIC ACIDS

$(MoO_3)(C_4H_4O_5Na_2)$ *Sodium molybdenylmalate* $[M]_D$. (**77**, *cf.* **75**)

t \ p	11.020	6.046	3.175	1.633	0.827	0.416
15	190.2	189.0	188.2	187	185	181
30	178.7	177.5	176.8	175	173	170
45	163.6	162.4	162.0	160	158	155
60	146.0	144.8	144.0	142	140	136
75	125.9	124.6	123.2	122	120	115
90	102.8	101.2	99.7	98	96	93

p=per cent of malic acid: the solutions are N/1, 2, 4, 8, 16, 32.

$(MoO_3)_2(C_4H_4O_5Na_2)$ *Sodium dimolybdenylmalate* $[M]_D$. **(77 *cf.* 75)**

t \ p	5.748	3.094	1.608	0.821	0.414	0.208
15	958.5	951.5	945	935	920	905
30	954.7	946.8	938	922	903	881
45	947.0	937.7	928	903	876	828
60	934.1	915.9	895	860	795	717
75	913.0	884.4	849	777	672	509
90	877.6	832.5	766	661	496	218

p = per cent of malic acid: the solutions are $N/2$, 4, 8, 16, 32, 64.

$MoO_2(C_4H_4O_5Na)_2$ *Sodium molybdenyldimalate* $[M]_D$. **(77; *cf.* 75)**

t \ p	11.792	6.275	3.241
10	−121.4	−119.8	−114.2
20	125.8	122.9	115.7
30	128.7	124.7	116.5
40	130.4	125.8	117.1
50	[1] 131.6	[1] 126.8	[1] 117.6
60	131.5	125.0	114.4
70	130.9	123.3	110.6
80	129.9	120.0	105.6
90	127.6	115.1	98.6
95	125.9	111.6	93.1

[1] Maximum.

p = Per cent of malic acid: the solutions are $N/1$, 2, 4.

$MoO_2(C_4H_5O_5K)_2$ *Potassium molybdenyldimalate* $[M]_D$. **(75)**

t \ p	6.975	3.619	1.843
20	+382.2	+379.3	+377
45	381.4	378.3	374
70	380.1	374.6	365
95	372.6	359.4	342

p = Per cent of malic acid.

$MoO_2(C_4H_4O_5NH_4)_2$ *Ammonium molybdenyldimalate* $[M]_D$. **(77; *cf.* 75)**

t \ p	12.107	6.367	3.270	1.658	0.835
10	−122.0	−121.4	−120.2	−109	−103
20	125.7	125.1	123.7	112	107
30	128.7	128.0	125.2	113	109
35	[1] 129.5	[1] 128.7	[1] 125.8	[1] 114	[1] 110
40	129.3	128.2	125.6	113	109
50	129.1	128.2	123.7	109	103
60	128.6	126.2	120.6	103	94
70	126.5	123.6	115.9	96	81
80	123.8	120.3	109.6	86	67
90	120.7	116.5	102.5	75	52
95	118.9	114.8	99.6	71	45

[1] Maximum.

p = per cent of malic acid: the solutions are $N/1$, 2, 4, 8, 16.

$MoO_3(C_4H_4O_6Na_2)$ *Sodium molybdenyltartrate* $[M]_D$. (76)

t \ p	12.308	6.781	3.569	1.831	0.928	0.467	0.234	0.117
20	832.4	813.8	787.6	750	629	695	538	421
40	815.4	797.6	769.1	729	602	671	509	386
70	791.8	778.6	717.0	704	561	636	443	300
90	767.7	758.6	722.5	676	502	600	363	225

p = per cent of tartaric acid: the solutions are $N/1$, 2, 4, 8, 16, 32, 64, 128.

$(MoO_3)_2(C_4H_4O_6Na_2)$ *Sodium dimolybdenyltartrate* $[M]_D$. (76)

t \ p	6.403	3.461	1.803	0.920	0.465	0.233
15	1324.9	1223	1039	802	662	592
30	1188.7	1098	918	710	592	524
45	1037.7	926	785	611	514	450
60	894.9	777	668	516	443	382
75	771.0	651	566	434	379	320
90	666.2	565	484	375	323	270

p = per cent of tartaric acid: the solutions are $N/2$, 4, 8, 16, 32, 64.

$MoO_2(C_4H_4O_6K)_2$ *Potassium molybdenylditartrate* $[M]_D$. (76)

t \ p	6.975	3.619	1.843	0.929	0.467	0.235
20	382.2	379.3	377	372	362	365
45	381.4	378.3	374	368	361	353
70	380.1	374.6	365	351	338	320
95	371.6	359.4	342	316	283	246

p = per cent of tartaric acid: the solutions are $N/2$, 4, 8, 16, 32, 64.

$WO_3(C_4H_4O_5Na_2)$ *Sodium tungstylmalate* $[M]_D$. (77)

t \ p	10.202	5.792	3.107	1.601	0.822	0.415
10	28.0	+29.2	+32.2	+56	+91	+124
30	28.6	31.2	38.5	64	98	131
50	30.3	36.7	51.6	81	116	139
70	33.8	45.6	66.3	103	137	150
95	37.3	57.8	82.2	124	159	162

p = per cent of malic acid; the solutions are N/1, 2, 4, 8, 16, 32.

$WO_2(C_4H_4O_5Na)_2$ *Sodium tungstyldimalate* $[M]_D$. (77)

t \ p	12.268	6.134	3.211	1.640
10	−99.6	−98.5	−97.1	−91
20	104.3	102.7	100.9	93
30	107.6	105.4	102.8	94
40	110.1	107.7	103.2	95 Max.
50	112.0	109.0	104.1 Max.	94
60	113.4	110.1 Max.	103.8	93
70	113.7 Max.	109.5	101.9	91
80	113.4	108.1	98.0	88
90	112.8	106.2	93.8	82
95	112.4	105.0	91.2	77

p = per cent of malic acid; the solutions are N/1, 2, 4, 8.

$WO_3(C_4H_4O_6Na_2)$ *Sodium tungstyltartrate* $[M]_D$. (76)

t \ p	11.390	6.486	3.484	1.409	0.922	0.465
20	482.8	463.5	442.4	420	395	360
40	476.1	455.7	432.8	405	378	344
70	466.7	447.2	421.3	390	354	316
90	459.3	437.5	411.9	381	336	291

p = per cent of tartaric acid: the solutions are N/1, 2, 4, 8, 16, 32.

$(WO_3)_2(C_4H_4O_6Na_2)$ *Sodium ditungstyltartrate* $[M]_D$. (76)

t \ p	5.833	3.283	1.751	0.906	0.461	0.232
10	220.2	208.1	197	191	183	179
20	213.6	203.0	191	186	178	171
30	208.1	198.3	186	182	174	163
40	203.2	194.1	182	178	170	155
50	198.7	190.3	179	175	166	150
60	194.8	186.8	175	172	163	145
70	191.4	183.7	172	170	159	141
80	188.7	180.7	169	168	158	139
90	186.6	177.8	167	166	157	137
95	185.8	176.6	167	164	156	134

p = per cent of tartaric acid: the solutions are N/2, 4, 8, 16, 32, 64.

$WO_2(C_4H_4O_6Na)_2$ *Sodium tungstylditartrate* $[M]_D$. (76)

t \ p	12.582	6.845	3.580	1.832	0.927
10	242.4	242.7	243.5	247	256
20	245.9	247.2	248.2	252	262
30	248.5	249.9	251.7	255	264
40	250.9	252.4	254.3	257	265
50	253.0	254.4	255.9	258	264
60	255.0	256.1	257.2	258	263
70	256.4	257.6	257.0	256	261
80	257.5	257.4	256.3	254	256
90	257.9	256.6	254.7	251	248
95	258.1	256.0	252.8	250	244

p = per cent of tartaric acid: the solutions are N/1, 2, 4, 8, 16.

VI. Class IV. SUBSTANCES OF UNKNOWN, DOUBTFUL, OR COMPLEX STRUCTURE

29. ALKALOIDS AND DERIVATIVES

$C_{20}H_{24}N_2O_2$ *Quinine* $[\alpha]_D^t$ $s=EtOH$ *(abs.)* **(138)**

t \ c	1	2	3	4	5	6
0	−171.4	−169.6	−167.9	−166.1	−164.2	−162.4
5	−170.5	−168.7	−167.0	−165.2	−163.4	−161.6
10	−169.6	−167.8	−166.1	−164.4	−162.7	−160.9
15	−168.9	−167.1	−165.4	−163.7	−162.1	−160.4
20	−168.2	−166.6	−164.8	−163.2	−161.6	−159.8

$C_{20}H_{25}ClN_2O_2$ *Quinine hydrochloride* **(83)**

s=H₂O+EtOH		s=H₂O+EtOH	
$c=2.$ $t=15°$		$c=2.$ $t=15°$	
Per cent EtOH	$[\alpha]_D$	Per cent EtOH	$[\alpha]_D$
97	−143.86	60	−187.75
90	−160.75	50	−187.50
85	−168.25	40	−182.82
80	−174.75	20	−166.59
70	−182.27	0	−138.75

$C_{19}H_{22}N_2O$ *Cinchonine salts* (89; *cf.* 84, 85)

Formula	Name	$c=$	2.5	5.0
		s	$[\alpha]_D^{20}$	$[\alpha]_D^{20}$
$C_{19}H_{22}N_2O$	Cinchonine	EtOH	224.5	(c=0.5)
$C_{33}H_{50}N_2O_3$	Myristate	$CHCl_3$	134.2	133.5
$C_{35}H_{54}N_2O_3$	Palmitate	$CHCl_3$	126.3	127.8
$C_{37}H_{58}N_2O_3$	Stearate	$CHCl_3$	121.4	122.3

Derivatives of cinchonine and cinchonidine (87)

s=CHCl₃ c=2.0		Cinchonine	Cinchonidine
Formula	Name	$[\alpha]_D^{13}$	$[\alpha]_D^{13}$
$C_{21}H_{24}N_2O_2$	Acetyl-	108.5	12.90
$C_{25}H_{26}N_2O_3S$	Benzenesulphonyl-	62.15	11.43
$C_{26}H_{26}N_2O_2$	Benzoyl-	−27.80	98.65

($C_{23}H_{26}N_2O_4$) *Brucine salts, s* = $CHCl_3$ (85, 86, 87, 89)

Formula	Name	$c=2.5$ $[M]_D^{15}$	$c=5.0$ $[M]_D^{15}$
$C_{25}H_{30}N_2O_6$	Acetate	260. 6	258. 0
$C_{26}H_{32}N_2O_6$	Propionate	252. 3	248. 1
$C_{27}H_{34}N_2O_6$	*n*-Butyrate	251. 2	247. 4
$C_{28}H_{36}N_2O_6$	*n*-Valerate	251. 6	247. 4
$C_{29}H_{38}N_2O_6$	*n*-Caproate	252. 8	246. 8
	$t=14.5-20°$ C.	$[M]_D$	$[M]_D$
$C_{23}H_{26}N_2O_4$	Brucine	121. 0	121. 5
$C_{25}H_{30}N_2O_8$	Glyoxylate	−61. 3	−60. 7
$C_{26}H_{30}N_2O_7$	Pyruvate	−86. 2	−85. 2
$C_{27}H_{32}N_2O_7$	Acetoacetate	−53. 7	−54. 7
$C_{28}H_{34}N_2O_7$	Levulinate	−177. 9	−175. 5
$C_{29}H_{34}N_2O_6$	Sorbate	−120. 6	−130. 0
$C_{29}H_{36}N_2O_6$	*β*, *γ*-Dihydrosorbate	−214. 2	−227. 2
$C_{30}H_{32}N_2O_6$	Benzoate	−129. 0	−131. 1
$C_{31}H_{32}N_2O_7$	Phenylglyoxylate	−33. 4	−32. 6
$C_{32}H_{34}N_2O_7$	Phenylpyruvate	+18. 5	+20. 4
$C_{32}H_{34}N_2O_7$	Benzoylacetate	−188. 8	−180. 0
$C_{33}H_{36}N_2O_7$	*β*-Benzoylpropionate	−182. 4	−184. 1
$C_{33}H_{34}N_2O_8$	Benzoylpyruvate	+66. 1	+60. 1
$C_{33}H_{36}N_2O_7$	Benzylpyruvate	−55. 5	−54. 9
$C_{35}H_{36}N_2O_8$	Piperate	−28. 6	−30. 7
$C_{35}H_{38}N_2O_8$	*α*, *β*-Dihydropiperate	−154. 3	−154. 1
$C_{35}H_{38}N_2O_8$	*β*, *γ*-Dihydropiperate	−179. 1	−178. 5
$C_{36}H_{40}N_2O_8$	Piperonylbutyrate	−170. 5	−174. 1
$C_{37}H_{54}N_2O_6$	Myristate	246. 7	246. 8
$C_{39}H_{58}N_2O_6$	Palmitate	248. 4	247. 5
$C_{41}H_{62}N_2O_6$	Stearate	247. 7	247. 4
	Dibrucine salts		
$C_{49}H_{56}N_4O_{14}$	Mesoxalate	−191. 9	−189. 1
$C_{50}H_{56}N_4O_{13}$	Oxalacetate	−357. 0	−362. 4
$C_{51}H_{58}N_4O_{13}$	Acetonedicarboxylate	−428. 2	−428. 2
$C_{48}H_{54}N_4O_{12}$	Oxalate	−24. 6	−26. 3
$C_{49}H_{56}N_4O_{12}$	Malonate	−470. 6	−470. 6
$C_{50}H_{58}N_4O_{12}$	Succinate	−580. 9	−591. 6
$C_{51}H_{60}N_4O_{12}$	Glutarate	−464. 4	−465. 8
$C_{52}H_{58}N_4O_{12}$	Muconate	−90. 4	−88. 5
$C_{52}H_{60}N_4O_{12}$	*α*, *β*-Dihydromuconate	−359. 0	−354. 6
	β, *γ*-Dihydromuconate	365. 5	−358. 8
$C_{52}H_{62}N_4O_{12}$	Adipate	397. 8	399. 2
$C_{53}H_{64}N_4O_{12}$	Pimelate	417. 9	405. 2
$C_{54}H_{66}N_4O_{12}$	Suberate	457. 5	439. 6
$C_{55}H_{68}N_4O_{12}$	Azelate	444. 2	440. 8
$C_{56}H_{70}N_4O_{12}$	Sebacate	479. 5	477. 5
$C_{58}H_{62}N_4O_{12}$	Cinnamylidenemalonate	98. 99	----------
$C_{58}H_{64}N_4O_{12}$	*α*, *β*-Dihydrocinnamylidenemalonate	439. 5	−444. 2
	β, *γ*-Dihydrocinnamylidenemalonate	505. 2	−509. 2

VII. Class V. INFLUENCE OF SALTS AND OTHER SUBSTANCES ON ROTATORY POWER

Influence of salts on rotatory power (48)

(*a*) $C_3H_6O_3$ *l*-lactic acid (containing 8 per cent *d*-lactic acid)

$s=H_2O$ $t=15°$ C.

Salt	c of salt	p	$d^{15°}$	$[\alpha]_{5,461}^{15}$
Nil		10.73	1.027	−2.2
NaCl	23.4	8.71	1.162	−7.6
NaBr	41.2	7.65	1.293	−8.0
$BaBr_2$	59.2	6.79	1.485	−17.7

(*b*) $C_4H_8O_3$ Methyl *l*-lactate (containing 5 per cent methyl *d*-lactate)

s	p	d^{20}	$[\alpha]_{5,461}^{20}$
Nil	100	1.093	8.4
H_2O	10.0	1.012	1.4
N NaCl	10.0	1.050	.5
$4N$ NaCl	10.37	1.150	−2.1
N NaBr	10.0	1.080	.5
N KCl	10.0	1.054	.5
N NH_4Cl	10.0	1.027	.9
N $CaCl_2$	10.0	1.054	−1.0
N $BaCl_2$	10.0	1.094	−1.3
$4N$ $BaBr_2$	9.81	1.456	−9.1

(*c*) $C_3H_6O_4$ *d*-Glyceric acid

$s=H_2O$

Salt	c of salt	p	d^{20}	$[\alpha]_{5,461}^{20}$
Nil		2.40	1.01	0.0
NaCl	23.4	1.84	1.17	4.9
$BaBr_2$	20.8	1.90	1.22	6.9

(*d*) $C_3H_7NO_2$ *d*-Alanine

s	c	$[\alpha]_{5,461}^{15}$
H_2O	10.0	2.9
N KCl	10.0	3.0
N NaCl	10.0	3.3
N $BaCl_2$	10.0	3.5
$4N$ $BaBr_2$	10.0	4.8
$1.5M$ HCl	5.78	17.8

(*e*) $C_5H_9NO_4$ *d*-Glutamic acid

s	p	d^{25}	$[\alpha]_{5,461}^{25}$
H_2O	1.50	1.003	13.3
N NaCl	1.50	1.043	14.4
$4N$ NaCl	1.51	1.152	15.8
N KCl	1.53	1.050	14.8
N $BaCl_2$	1.53	1.092	14.4
$4N$ $BaBr_2$	1.51	1.500	18.1
M NaOH	12.25	1.075	−3.6
$2M$ NaOH	6.55	1.050	11.7
$1.5M$ HCl	8.75		37.4

Influence of salts on rotatory power (48)—Continued

(*f*) Influence of NaBr

s=MeOH c=10 +N NaBr

		$[\alpha]^{15}_{5,461}$	$[\alpha]^{15}_{5,461}$
$C_4H_6O_5$	*l*-Malic acid	−5. 9	21. 8
$C_4H_6O_6$	*d*-Tartaric acid	2. 6	−9. 0
$C_4H_8O_3$	Methyl *l*-lactate	5. 4	−5. 8
$C_6H_8O_5$	Dimethyl *l*-malate	−9. 4	9. 1
$C_6H_8O_6$	Dimethyl *d*-tartrate	2. 7	−12. 6
$C_{10}H_{14}O_8$	Dimethyl *d*-diacetoxysuccinate (c=4)	−18. 3	−12. 2
$C_{12}H_{18}O_8$	Diethyl *d*-diacetoxysuccinate (c=5)	3. 6	7. 6

(*g*) Influence of sodium halides

Formula	Name	s	c	t	$[\alpha]^{t}_{5,461}$
$C_9H_{10}O_3$	*d*-β-Phenyllactic acid	H_2O	2. 505	20	25. 5
		N NaCl	. 665	20	13. 5
		MeOH	10. 0	20	21. 0
		N NaBr in MeOH	10. 0	20	−2. 0
$C_{10}H_{12}O_3$	Methyl *d*-β-phenyllactate	MeOH	10. 0	18	−4. 5
		N NaBr in MeOH	10. 0	18	−22. 3

(*h*) $C_8H_{15}NO_4$ Ethyl *l*-aspartate

s	c	$[\alpha]^{15}_{5,461}$
Nil		−11. 7
C_6H_6	10. 92	−12. 6
$CHCl_3$	11. 02	−9. 7
Me_2CO[1]	20. 0	−8. 8
H_2O	21. 7	4. 2
	12. 25	4. 2
4 N NaCl	10. 81	6. 7
4 N $BaBr_2$	14. 50	11. 5
5 N $CaCl_2$	13. 21	14. 5
N HCl	11. 37	12. 0
MeOH	20. 0	−0. 5
N NaBr in MeOH	20. 0	4. 3

[1] Ethyl *l*-aspartate reacts with Me_2CO; α_{gr}=−3.50 to −56.6 (c=20) in 15 hours

(*i*) Effect of temperature

(1) $C_3H_6O_3$ *l*-Lactic acid in aqueous solution (containing 8 per cent *d*-lactic acid) p=10.73

t	15	18	36	52	62	70
d^t	1. 03	1. 03	1. 02	1. 01	1. 01	1. 00
$[\alpha]^{t}_{5,461}$	−2. 2	−2. 0	−0. 7	±0. 0	0. 4	0. 7

Influence of salts on rotatory power (48)—Continued

(2) $C_4H_8O_3$ Methyl *l*-lactate (containing 5 per cent methyl *d*-lactate)

s=Nil				
t	d^t	$[\alpha]^t_{5,893}$	$[\alpha]^t_{5,461}$	$[\alpha]^t_{4,078}$
15	1.097	7.26	8.25	10.89
20	1.093	7.46	8.39	11.21
s=H_2O				
p	d^{20}	$[\alpha]^{20}_{5,893}$	$[\alpha]^{20}_{5,461}$	$[\alpha]^{20}_{4,078}$
100	1.093	7.46	8.39	11.21
80.0	1.086	4.1	4.4	4.5
50.9	1.063	2.1	2.5	1.0
20.0	1.026	1.8	1.8	−0.2
10.0	1.012	1.3	1.4	−0.5
5.36	1.005	1.3	1.4	−0.9

Effect of salts on the rotatory power of $C_3H_7NO_2$ d-alanine (48)

s	c	$[\alpha]^{15}_{4,359}$
H_2O	10.0	2.9
N KCl	10.0	3.0
N NaCl	10.0	3.3
N $BaCl_2$	10.0	3.5
N $BaBr_2$	10.0	4.8
1.5 *M* HCl	5.78	17.8

Influence of inorganic salts on the rotation of $C_4H_6O_5$, *malic acid*

s=H_2O, n=number of gram equivalents of salt added to 500 g of 20 per cent malic acid solution. (214; cf., 8, 53, 182, 183, 207, 214, 223)

Δ=Change in $[\alpha]_D$ due to the presence of the salt

Salt	d_4^{20}	n	Δ
NH_4Cl	1.086	¼	1.16
	1.103	1	3.28
$(NH_4)_2SO_4$	1.0965	¼	.65
	1.1418	1	1.98
NH_4NO_3	1.0938	¼	1.11
	1.131	1	3.00
$AlCl_3$	1.0985	¼	.60
	1.1547	1	2.63
$Al_2(SO_4)_3$	1.1075	¼	.40
$ZnCl_2$	1.1105	¼	.56
	1.1915	1.015	2.55
$ZnSO_4$	1.118	¼	.00
	1.2247	0.998	1.06
$Zn(NO_3)_2$	1.119	¼	.55
	1.2283	1	2.81
$Cd(NO_3)_2$	1.1291	¼	.73
	1.267	1	3.11
$HgCl_2$	1.126	⅕	.36
$Hg(NO_3)_2$	1.1495	¼	−3.36
	1.3472	1	−3.58
$MgCl_2$	1.0995	¼	.77
	1.1556	1	2.82
$MgSO_4$	1.1095	¼	.34
	1.1935	1	1.51
$Mg(NO_3)_2$	1.107	¼	.81
	1.1817	1	2.65
$CaCl_2$	1.1018	¼	3.95
	1.166	1.019	14.81

Salt	d_4^{20}	n	Δ
$Ca(NO_3)_2$	1.1155	0.2998	4.37
	1.1917	1	12.07
$BaCl_2$	1.1256	¼	5.58
	1.2566	1	17.23
$Ba(NO_3)_2$	1.133	¼	4.83
LiCl	1.091	¼	.73
	1.123	1	2.84
NaCl	1.0993	¼	1.67
	1.153	1	5.39
Na_2SO_4	1.1103	¼	1.14
	1.181	⅞	3.38
$NaNO_3$	1.107	¼	1.61
	1.180	1	4.64
KCl	1.0905	⅛	1.04
	1.1013	¼	1.95
	1.123	½	3.49
	1.1618	1	5.57
KBr	1.1215	¼	2.11
	1.2363	1	6.00
KI	1.1397	¼	2.39
	1.3015	1	6.79
K_2SO_4	1.1126	¼	1.48
KNO_3	1.1095	¼	1.88
	1.882	1	4.51
RbCl	1.1223	¼	1.95
	1.2417	1	5.08
CsCl	1.1442	¼	1.94
	1.3185	1	4.66

$C_4H_6O_6$ *Tartaric acid, effect of metallic salts on rotation* (**129**)

Salt	c		$[\alpha]_{5,780}$	$\lambda \rightarrow$	$[\alpha]_\lambda$			
	Of salt	Of acid	For acid alone	$t \downarrow$	5,780	5,461	4,920	4,359
$NaCl$	24.8	39.1	9.1	17	−3.2	−4.4	−8.0	−17.5
$CaCl_2$	42.7	30.2	10.2	17	−42.5	−49.0	−64.9	−95.0
$SrCl_2$	41	25.8	10.9	19	−16.3	−19.4	−27.1	−43.2
$BaCl_2$	28	47.0	8.2	17	−11.2	−13.5	−19.0	−33.8
$MgCl_2$	25	19.1	11.9	17	7.4	7.5	6.8	3.8
$ZnCl_2$	22	24.4	11.0	18	9.6	9.9	9.9	8.0
$NaNO_3$	36	21.8	11.3	18	0.2	−0.6	−3.0	−10.5
$Ca(NO_3)_2$	40	21.8	11.3	20	−14.0	−17.0	−24.1	−38.9
$Sr(NO_3)_2$	32	21.8	11.3	20	−5.4	−7.0	−12.0	−22.5
$Ba(NO_3)_2$	8	21.8	11.3	18	5.2	4.9	−3.7	−1.0

Influence of sodium and barium halides on the rotatory power of derivatives of succinic acid in aqueous solution (**45, 46**)

Formula	Name	p	s	t	$[\alpha]_D^t$
$C_4H_6O_5$	Malic acid	16.67	H_2O	25	−1.55
		13.95	4 M[1] $NaCl$	25	4.80
		11.15	2 M $BaBr_2$	25	21.8
$C_4H_6O_6$	Tartaric acid	16.67	H_2O	25	12.98
		15.2	2 M $NaCl$	25	7.62
		14.22	2 M $NaBr$	25	7.03
		13.33	2 M NaI	25	5.11
		14.20	1 M $BaCl_2$	25	−1.58
		13.36	1 M $BaBr_2$	25	−2.34
		11.15	2 M $BaBr_2$	25	−8.83
$C_5H_8O_6$	Methyl hydrogen tartrate	19.67	H_2O	25	14.8
		20.05	5 M $NaCl$	25	3.7
		19.6	2.5 M $BaBr_2$	25	−8.37
$C_6H_{10}O_5$	Dimethyl malate	50.0	H_2O	25	−8.58
		43.62	5 M $NaCl$	25	−1.65
		36.4	2.5 M $BaBr_2$	25	9.00
$C_6H_{10}O_6$	Dimethyl tartrate	49.77	H_2O	16.7	[2] 14.71
		43.62	5 M $NaCl$	16.0	.73
		36.45	2.5 M $BaBr_2$	17.0	−12.02
$C_8H_{14}O_6$	Diethyl tartrate	50.0	H_2O	19.9	[3] 17.34
		43.62	5 M $NaCl$	17.0	2.19
		36.45	2.5 M $BaBr_2$	15.0	−7.93

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[1] Moles of salt per 1000 g of water, throughout the table. [2] See (143). [3] See (142).

Effect of the addition of various salts on the rotation of $C_8H_{16}O_6$ *Diethyl tartrate.* (**147**)

$c=11.84$[1]

s	$[d]_4^{26}$	$[\alpha]_D^{26}$	s	$[d]_4^{26}$	$[\alpha]_D^{26}$
H_2O	1.021	26.37	M $NaBr$	1.127	19.86
M NH_4Cl	1.046	22.56	M KBr	1.151	18.41
M $NaCl$	1.088	20.32	M $(NH_4)_2SO_4$	1.129	18.73
M KCl	1.097	19.59	M $KCNS$	1.091	17.28
M NH_4NO_3	1.068	22.50			
			M $NaClO_4$	1.132	18.78
M $NaNO_3$	1.110	19.06	M $NaC_2H_3O_2$	1.087	18.25
M KNO_3	1.119	19.34	M $CO(NH_2)_2$	1.058	27.29
M NaI	1.201	16.26	M $BaCl_2$	1.127	13.94
M KI	1.211	16.69			

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[1] The concentrations of ester and of salt are relative to 100 g. of water.

Effect of inactive substances on the rotation of tartaric acid

1. Inorganic and organic acids (**23, 110, 178, 217**).
2. Organic bases (**178, 179**).
3. Organic halide and nitro compounds (**179**).
4. Alcohols (**22, 110, 178**).
5. Benzene and homologues (**179**).
6. Boric acid (**24, 139**).
7. Alkalies (**3, 219**).
8. Alkali salts (**113, 208, 218**).

Influence of acid, alkali, and salts on the rotatory power and rotatory dispersion of aspartic acid and asparagine (**47**)

($C_4H_7NO_4$) *l*-Aspartic acid

s	Moles of acid or alkali per mole of substance	p	t	$[\alpha]_{5,893}$	$[\alpha]_{5,461}$	$[\alpha]_{4,358}$
H_2O		0.990	25	3.8	6.0	14.0
		1.961	48	2.3	4.0	9.3
		1.961	68	±0.0	1.3	4.5
		1.961	78	−1.5	−.3	2.3
N HCl	1.5	7.984	25	25.0	29.9	63.5
0.2 *N* NaOH	1.0	2.584	25	−17.3	−19.3	−33.6
N NaOH	1.0	11.30	25	−6.0	−6.9	−9.4
2 *N* NaOH	1.0	19.76	25	.5	1.5	5.5
N NaOH	2.0	6.0	25	−2.4	−2.1	1.8
0.2 *N* NaOH	2.0	1.303	25	−6.9	−4.8	−1.5
2 *N* NaOH	2.0	11.02	25	−.7	−.3	4.3
N NaCl		1.011	25	9.5	12.7	28.6
4 *N* NaCl		.944	25	18.4	21.5	47.9
N $BaCl_2$		1.047	25	13.7	16.7	33.7
4 *N* $BaCl_2$		1.007	25	21.2	25.4	50.3
($C_4H_8N_2O_3$) *l*-Asparagine						
H_2O		1.961	34	−6.7	−7.5	−14.7
		1.961	40	−7.7	−8.3	−17.7
		1.961	60	−10.5	−11.3	−22.4
		7.407	52	−8.3	−9.3	−18.3
N HCl	1.5	8.942	25	27.9	33.7	70.4
N NaOH	1.0	12.44	25	−8.8	−10.0	−19.9

$C_4H_8N_2O_3$, Asparagine, effect of dilute acids on rotation of 1 mole asparagine+300 moles H_2O (18)

M HCl	$[\alpha]_D^{20}$	M H_2SO_4	$[\alpha]_D^{20}$	M AcOH	$[\alpha]_D^{20}$
1	26.4	0.5	23.1	1	−3.49
1.5	30.4	0.75	27.3	2	−3.10
2	31.5	1	29.5	5	−1.45
3	31.9	3	32.0	7	−0.59
5	32.3	5	34.3	10	0.00
10	33.3	10	35.5	15	1.11
15	33.7			20	2.63
20	34.3				

Influence of acid, alkali and salts on rotatory power of $C_5H_9NO_4$ *d*-glutamic acid (48)

s	p	$[\alpha]_{4,359}$	s	p	$[\alpha]_{4,359}$
H_2O	1.50	13.3	4 *N* $BaBr_2$	1.51	18.1
N NaCl	1.50	14.4	1 *M* NaOH	12.25	−3.6
4 *N* NaCl	1.51	15.8	2 *M* NaOH	6.55	11.7
N KCl	1.53	14.8	1.5 *M* HCl	8.75	37.4
N $BaCl_2$	1.53	14.4			

Influence of boric acid on $C_6H_{14}O_6$ mannitol

(a) with H_3BO_3 (62)

s=H^2O. c=10

$\frac{M H_3BO_3}{M C_6H_{14}O_6}$	$[\alpha]^{18}_D$
0.8	3.1
1.5	4.3
2.0	5.2

s=H_2O. c=15

$\frac{M H_3BO_3}{M C_6H_{14}O_6}$	$[\alpha]^{18}_D$
0.4	1.5
.8	3.6
1.0	4.5
1.3	5.4
1.5	5.9

s=EtOH. c=6

$\frac{M H_3BO_3}{M C_6H_{14}O_6}$	$[\alpha]^{18}_D$
1.8	13.9
2.0	15.6
3.0	19.7
4.0	23.9
5.0	25.4
6.0	27.2

s=EtOH. c=10

$\frac{M H_3BO_3}{M C_6H_{14}O_6}$	$[\alpha]^{18}_D$
2.0	17.3
2.6	21.1
3.0	22.9
3.5	24.6

s=EtOH. c=12

$\frac{M H_3BO_3}{M C_6H_{14}O_6}$	$[\alpha]^{18}_D$
2.2	20.2
3.0	25.2
4.0	28.7

s=H_2O. c=3.555

$\frac{M C_6H_{14}O_6}{M H_3BO_3}$	$[\alpha]^{15}_D$ (137)
6	−0.73
5	.38
4	1.69
3	1.83
2	2.03
1	2.25
.5	3.77
.333	5.57
.25	6.76

(b) with NaOH (137)

$\frac{M C_6H_{14}O_6}{M H_3BO_3}$	$[\alpha]^{15}_D$
10	−0.37
9	−.47
8	−.70
7	−.83
6	−.86
5	−1.04
4	−1.30
3	−1.95
2	−2.59
1	−3.43

(c) with $NaBO_2$ (137)

$\frac{M C_6H_{14}O_6}{M NaBO_2}$	$[\alpha]^{15}_D$
20	−0.078
17	.004
15	.397
13	.873
11	1.357
9	1.737
7	2.193
5	3.439
3	5.169
1	19.746

Influence of boric acid on derivatives of mannitol (92) s=H_2O N/2 H_3BO_3

Formula	Name	c	$[\alpha]^{20}_D$	$[\alpha]^{20}_D$
$C_6H_{14}O_6$	Mannitol		−0.25	28.3
$C_8H_{18}O_6$	ε, ζ-Dimethylmannitol	N/4	−7.35	−3.88
$C_{10}H_{22}O_6$	γ, δ, ε, ζ-Tetramethylmannitol	N/8	−13.02	−6.72
	β, γ, ε, ζ-Tetramethylmannitol	N/8	38.54	40.64
$C_9H_{18}O_6$	Mannitolmonoacetone	N/4	30.61	29.50
$C_{11}H_{24}O_6$	Pentamethylmannitol	N/2	7.54	8.25
$C_{12}H_{22}O_6$	Mannitoldiacetone	N/8	23.04	22.43

The influence of papaverine on the optical activity of narcotine in acid solution (5)

c		Length of tube=2 dcm.	
$C_{22}H_{23}NO_7$	$C_{20}H_{21}NO_4$	$[\alpha]^{31}_{5,461}$	
Narcotine	Papaverine	in 1 per cent H_2SO_4	in 1 per cent HCl
2.0	0.0	2.61	2.23
.0	.5	.02	0.02
2.0	.5	2.24	1.76
2.0	.0	2.59	-------------
2.0	.5	2.19	-------------
2.0	1.0	2.00	-------------
2.0	2.0	1.69	-------------
2.0	3.0	1.49	-------------
2.0	4.0	1.45	-------------
s=PhMe			
1.333	0.00	−4.83	-------------
0.00	.50	±0.00	-------------
1.333	.50	−4.82	-------------
1.333	1.00	−4.84	-------------

Specific rotation of $C_{22}H_{23}NO_7$, narcotine (5)

s	PhMe	90 per cent EtOH	$CHCl_3$	1 per cent H_2SO_4	1 per cent HCl
c	2	0.4	2.0	2.0	1.0
t	32	31	33	32	29
$[\alpha]^t_{5,893}$	−148. 75		−198. 0	57. 25	50. 0
$[\alpha]^t_{5,780}$	−154. 5		−206. 5		52. 2
$[\alpha]^t_{5,461}$	−182	−203. 75°	−242. 3	65. 2	56. 5

Rotatory power of liquid crystals

For a layer 1 mm. thick; λ=5,893 (220)

(*a*) Esters of $C_{27}H_{46}O$ cholesterol

$C_{27}H_{45}Cl$	Chloride	−120
$C_{29}H_{48}O_2$	Acetate	−200
$C_{30}H_{50}O_2$	Propionate	5
$C_{31}H_{50}O_2$	Crotonate	[1] 180
$C_{31}H_{52}O_2$	*n*-Butyrate	50
$C_{32}H_{52}O_2$	Allylacetate	−190
$C_{33}H_{52}O_2$	Sorbate	480
$C_{34}H_{49}NO_4$	*o*-Nitrobenzoate	70
	m-Nitrobenzoate	100
	p-Nitrobenzoate	−1, 700
$C_{34}H_{50}O_2$	Benzoate	+80
$C_{36}H_{50}O_2$	Phenylpropiolate	30
$C_{36}H_{51}NO_4$	*p*-Nitrocinnamate	−6, 200
$C_{36}H_{52}O_2$	Cinnamate	−1, 400
$C_{36}H_{54}O_2$	Hydrocinnamate	−900
$C_{72}H_{102}N_2O_4$	*p*-Azocinnamate	10, 500

[1] Sign uncertain.

(*b*) Esters of active amyl alcohol

$C_{23}H_{25}NO_2$	Cinnamylideneaminocinnamate	9,500.
$C_{21}H_{22}N_2O_4$	*p*-Nitrobenzylideneaminocinnamate	6,000.
$C_{22}H_{22}N_2O_2$	Cyanobenzylideneaminocinnamate	8,000 to 13,000.
$C_{22}H_{25}NO_3$	Anisylideneaminocinnamate	6,000 to 8,000.
$C_{23}H_{27}NO_3$	Anisylideneamino-*a*-methylcinnamate	4,000 to 5,000.

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